The Foundry Trade Journal

AND PATTERN MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 19. MARCH, 1917. No. 183.

PUBLISHED THE FIRST WEEK IN EACH MONTH

Subscription Terms: 7s. 6d. per annum, post free.

To place the "Journal" within the reach of working Moulders and Pattern-makers, the Proprietors will accept subscriptions, not less than three in number from one shop, at the reduced rate of 5s. per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

The Foundry Trade Journal,
165, Strand, London, W.C.

OWING TO THE REDUCTIONS IMPOSED BY THE GOVERNMENT ON PAPER SUPPLIES, THE PROPRIETORS ARE COMPELLED TO PUBLISH "THE FOUNDRY TRADE JOURNAL" ON A THIN PAPER DURING THE CONTINUANCE OF THE RESTRICTIONS.

BRITISH FOUNDRYMEN'S ASSOCIATION.
LIST OF SECRETARIES—

General Secretary: E. A. Pilkington, 1, Clarence Villa, St. Catherines, Lincoln.
Manchester: A. Harrison, 705, Manchester Road, Castleton.
Birmingham: C. Grindlay, 39, Copeley Hill, Erdington, Birmingham.
Sheffield and District: J. Dickinson, 157, Abbeyfield Road, Pitsmoor, Sheffield.
Scottish: J. Macfarlane, 3, Sharrocks Street, Ibrox, Glasgow.
London: Alexander Hayes, 116, Rusthall Avenue, Bedford Park, W.
Halifax: J. G. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, Cleveland Road, North Shields.
East Midlands: H. Bunting, 38, Camp Street, Derby.

Contents.

	PAGE
Notes and Comments	127
Aluminium Control	128
Large Fly Wheel for a Rolling-Mill Engine	129
Brass Swarf and Scrap	132
The Functions of Feeders and Deseoners	133
Mechanical Tests for Cast Iron	137
Correspondence	139
Cast Iron	140
Institute of Metals	144
British Foundrymen's Association—	
Scottish Branch	144
Sheffield Branch	156
Repetition Work and Machine Moulding	146
Scientific Study of Refractory Materials	151
Gas Furnace Firing	153
Foundry Problems after the War	154
Trade Talk	158
Magnesium	156
Constitution and Treatment of Bronze	157
Applications or Patents	159
Personal	160
Deaths	160
The Control of Lead	162
Aluminium Stocks	162
New Companies	164
Monthly Price List	166

Forthcoming Events.

MARCH 10.

British Foundrymen's Association: Birmingham Branch.—"Foundry Facings," by H. Winterton.

MARCH 16.

British Foundrymen's Association: London Branch.—"General Foundry Practice," by T. W. Aitken.

MARCH 24.

British Foundrymen's Association: Birmingham Branch.—"The Influence of Casting Temperature on the Physical Properties of Metals," by F. H. Hurren.

British Foundrymen's Association: Scottish Branch.—"Cupola Notes," by R. B. Robinson.

MARCH 31.

British Foundrymen's Association: Lancashire Branch.—"Oil Sand Cores," by J. G. Robinson.

NOTES AND COMMENTS.

The Boy and the Trade.

Already we are being warned of the many problems that will have to be faced at the end of the war, and in the foundry trade particularly the problem of boy labour and apprenticeship will be serious. Some of the factors contributing to the problem were discussed in a Paper (page 154) by Mr. M. Disley, who remarked that great inducements in the shape of better pay were now offered to the young men of the nation to take up positions outside the foundry, and foundry employers should do something to counteract that influence. The education authorities should be appealed to, because it was well known that technical schools made better provision for almost every other trade than the foundryman. If foundrymen were going to do their duty in the building up of the new industrial Empire of the world the services of every moulder would be required. He suggested that the apprentices in the foundries ought to receive more consideration. In the past they had been sadly neglected, and greater opportunities should be afforded them for becoming good all round skilled workmen. It was not fair to impose excessively on their time in order to cheapen labour, with the result that at the end of their term they were only half trained. They were often kept too long on one particular class of work, which was not any real gain to the employer, and had a tendency to breed indifference in the youth.

The unpleasant working conditions that obtain in many foundries will also have to be remedied. The old objection, that where improved conditions and facilities have been afforded to foundrymen they have often been ignored, is really no argument at all. The prejudice and habits created by years of bad conditions cannot be overcome in a month, simply by installing a few wash-basins and a mess-room. The fact that old foundry hands are inured to unpleasant conditions of work and respite in the foundry has really no connection with the desirability of better conditions, particularly when the question of attracting young blood to the trade is under discussion. It is not a matter of whether an improvement enlists the appreciation of old hands, but of whether it will assist in a better standard of youth becoming attracted to the trade. Welfare work has in many instances met with admirable success, when the proper spirit was infused into the scheme.

Mr. C. W. Hodder, the welfare supervisor to Messrs. Denny, of Dumbarton, recently explained his scheme of welfare work among boys to a meeting of the Dumbarton Philosophical Society. Having referred to the readiness of employers to adopt such schemes and his peculiarly happy experience in Dumbarton, not only with Messrs. Denny but with Messrs. M'Millan, he said welfare-supervisors aimed at being character builders. They aimed to suggest, guide, and help the boys

to develop the best that was in them. He proposed to begin work by trying to get to know, personally and individually, every boy worker and potential boy worker in the place. He hoped to enlist the sympathy and help of parents, teachers, pastors, ministers—in short, anybody and everybody interested in the boy, his present and future. His idea was to supplement, not supplant, efforts. In the works he had free access to the lads and the sympathy and co-operation of foremen and heads of departments. He had a complete list of the boys, their home address, the trade in which they were occupied, and he was steadily and determinedly trying to gain their confidence. Each boy as he applied for work should be interviewed by the supervisor, and a record should be kept concerning him. The boy must see that he became part and parcel of a great industrial concern, not a mere floating atom, to be taken up or thrown out at the whim or caprice of any and everybody. His development must be steadily watched; the supervisor would visit each department daily, where the lads, trusting him, would turn to him in and difficulty and trouble.

This spirit should command success, for it is based on an endeavour to assist and not any mere attempt to become a moral dictator to the employés.

The Test-Bar Question.

Once again the test-bar question is to the fore, and again we find the present position severely criticised on the grounds that, as at present specified, the test bar for cast iron is practically useless. Mr. F. J. Cook (see page 137) remarks that "the question of test specifications for cast iron in this country is in a state of chaos, and the time is ripe for technical associations to take the matter in hand and evolve standard rules which shall at least have the result of making tests made made in various works comparative."

As a matter of fact, we consider that not only is the time ripe for such attention to the subject, but that the treatment is long overdue. Discussing the question at the end of 1915, we drew attention to the absurdity of existing practice, particularly since it has never been clear whether the claim for standardisation is put forward in the interests of high test-bar results, of sound castings regardless of the test bar, or of results in the test bar which will be representative of the casting; for these three are not always compatible. As then pointed out, the mechanical properties of a metal are of more importance than the chemical composition, and test bars are accordingly shaped for mechanical testing. But no matter where they may be cast, at top, bottom, or side of the mould, attached to or separate from the casting, they do not necessarily give any indication of the physical properties of the casting. So much is the strength of cast metal dependent on the rate of cooling, the method of gating, and the efficiency of the feeding head that a test-bar may be hopelessly misleading as to the results obtained. Nor is it clear just what would be gained by standardising test bars; for a bar properly cast may give excellent results and indicate that the iron, if properly run into a suitable mould and properly fed will give an excellent casting; but the same metal may be poured into a wrongly-gated and badly-fed casting, and in such a case the test bar is only misleading. Unless the bar indicates, with fair accuracy, the strength of the casting, we fail to see its value; and the fact that physical properties are governed by the mixture in relation to the design of the casting would suggest that every casting requires its own representative test bar suitably placed to produce physical properties akin to that of the casting itself. A metal suitable for running a thin cylinder of, say, 3-16 in. thickness would show different physical properties in a tensile test bar of, say, 1in. diameter, or in a transverse bar 1in. by 1 in.

Nevertheless, the fact that the whole question is surrounded by difficulties should not deter technical associations from tackling it. If they did nothing more than expose to certain inspectors the stupidity of many existing specifications and restrictions, the foundry trade would be well served. We still contend that so far as small castings are concerned, the only really safe way is to take a typical example and cut it through at the plane most likely to prove defective. This, of course, cannot be done with larger work, but in the latter case, while a test bar may serve to impress the inspector, it is frequently not worth the trouble involved in its examination. If sound castings are wanted and they cannot be tested hydraulically or by other means, the inspector should examine the method of moulding, gating, pouring, and feeding, and then the final casting. If he has not sufficient knowledge of metallurgy and founding to decide, the test bar won't help him.

Certainly the test bar, if it is used, should be standardised, for it at least would serve to show the quality and nature of the metal when properly cast. For this reason the bar should be cast under the most favourable conditions; and if it be deemed necessary to attach it to the casting to ensure the same metal being used, it should be attached to the pouring head by a suitable runner that would feed it properly.

Aluminium Control.

The Ministry of Munitions announces that all existing permits for the sale, purchase, or remelting of aluminium scrap and swarf are cancelled as from March 1. All dealings in these materials are now governed by the following regulations:—

1. No existing aluminium scrap and swarf may be used for any purpose excepting at the works where the same has been produced, and for contracts for which aluminium has been released by the Director of Materials, and as portion of the amount so released.

2. All existing aluminium scrap and swarf not being used at any works where the same has been produced for contracts for which aluminium has been released by the Director of Materials, and as portion of the amount so released, shall be sold and sent within three weeks from the first day of March, 1917, to the refiner or one of the refiners, as the case may be, nominated by the Ministry of Munitions for the district where such scrap or swarf is situated.

3. When aluminium scrap and swarf is produced hereafter such scrap and swarf must be used at the works where produced for contracts for which aluminium has been released by the Director of Materials, and as portion of the amount so released, or otherwise sold and sent at or before the end of each month to one or other of the refiners nominated by the Ministry of Munitions for the district where such scrap and swarf is situated.

Applications for permits should be made to the Director of Materials, A. M. (2) H., Hotel Victoria, Northumberland Avenue, W.C.

Large Fly Wheel for a Rolling-Mill Engine.

By Frank Andrew.

The following description relates to the method of making the moulds for a large fly wheel. Fig. 1 is a half-view in elevation of the assembled wheel, bolts not shown, from which it will be seen that the wheel is cast in seven pieces. Fig. 2 is a bolt plan at the joint of the arms and rim projections. Fig. 3 is a half plan at the joint of the two halves of the boss. Fig. 4 is a radial view in section of the boss, on *A B* Fig. 1. Fig. 5 is a radial view in section of the rim on *C D* Fig. 1. Fig. 6 is an end view of one of the segments at the joint *E F* Fig. 1. For dimensions of Figs. 1 to 6 see Scale A. Each of the five segments forming the rim weighs about 25 tons, and the two half-spiders for the centre each weigh about 20 tons.

Moulding the Spider.

In making the mould for one of the half-spiders a level bed is prepared in the floor, half circular in shape, and at such a depth that the top of the completed mould is about level with the foundry floor. Fig. 7 is a view in elevation of the bed showing a loam plate set in the centre, similar to the one shown in Fig. 12, except that it contains no riser holes, this forming the bottom face of the boss mould. On the face of this bed centre lines are made for setting the arm cores in position. Fig. 8 shows a plan of the mould with the bottom halves of the arm cores in position, also the cores for closing the ends of the arms, these carrying the bolt-hole cores, which are loose and pass into corresponding holes in the ends of the arm cores.

When these end cores have been tried in position and marked, they are laid down as shown at *A* till the upper halves of the arm cores are set. In this view (Fig. 8) the back plate, carrying the half-round centre core and forming the joint face of the boss as shown in Fig. 11 (two views), is also in position.

The upper halves of the arm cores can now be placed in position, the open ends allowing the moulder to get a good joint. All joints are made good, blacked and dried by small fires, and the mould then cleaned out to prepare for closing. The end cores are replaced, the round bolt-hole cores pushed up, and the joints luted up with black loam. The top plate shown in Fig. 12 is put on, and the four round cores, for holding the two halves of the boss together and which pass through the holes *B* in the back plate, Fig. 11, the smaller end lying in a print in the arm cores, are supported above and below by means of studs which touch the bottom face of the top plate.

The grids for the arm cores (see Fig. 10) are made fairly strong, and each has four lugs which serve for tying top and bottom cores together. The top and bottom plates have each seven lugs, and these also serve for tying the two plates together (see Fig. 12).

Fig. 9 is an elevation showing the mould in the pit bolted together, all ready for ramming up. The positions of the runner box and risers, one riser to each arm, are shown by dotted lines. The positions of the risers on the boss are marked by three small circles dotted (Fig. 8). The vents from the arm cores and the bottom plate are connected by means of cinders, in the spaces between the arms, and carried to the surface by means of pieces of piping. The four runners *R* (see Fig. 11) are extended by means of cores, shown in Fig. 17, to bring the

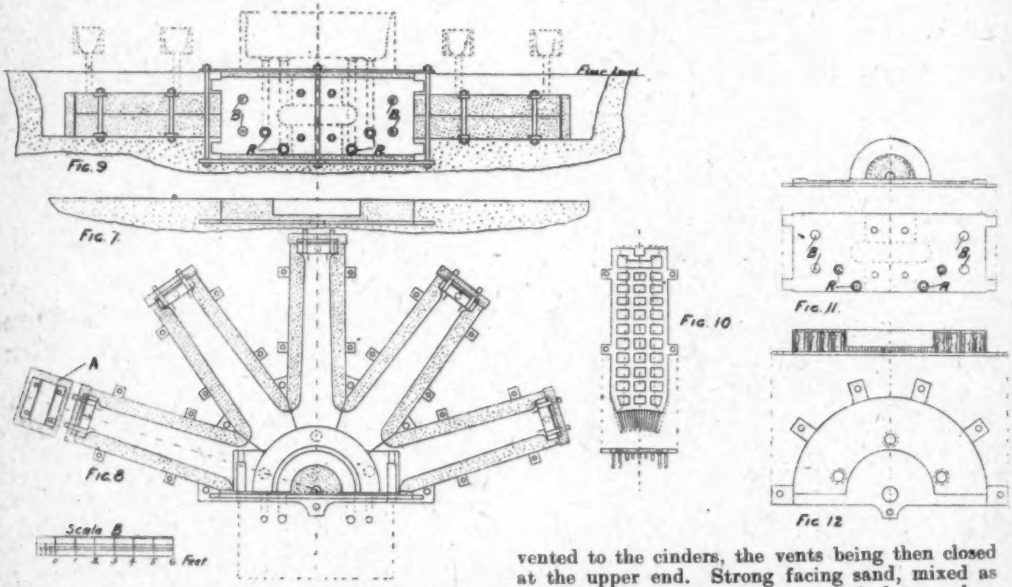
down-runners away from the back-plate, as ramming up proceeds, the wood down-runners being laid up to them. The back-plate is secured by props to the side of the pit and the vents from the back-plate and centre core carried away by means of ashes and pipes to the floor level.

The whole is now rammed level with the floor, the risers being kept covered to prevent the entry of any dirt or sand. Riser pegs are now put in at the ends of the arm cores and riser boxes made up as shown in Fig. 9. A large runner box, with a bottom plate containing holes for the down runners and lined with loam bricks, is placed in position as indicated by dotted lines in Figs. 8 and 9. Cores as shown in Fig. 19 to receive the stops and protect the upper end of the down-runners are fixed in position, and the bottom of runner box made good. Riser boxes are made up round the three risers on the boss, and the whole of the risers each covered with a handful of hay, covered with sand and a brick placed on end. As an extra precaution to prevent the air from the mould blowing the risers open, each riser is covered with a plate on which is placed a hand weight.

coming level, at the upper edge, with the foundry floor. These precautions are necessary to avoid the risk with such a large bulky casting, of the metal getting away, due to the possibility of there being an old pit in the vicinity which has been improperly filled in. Cross-beams pass under the bottom plate and links fixed to these and coming level with the foundry floor serve for tying the mould down when completed.

Ten short pillars are stood up on the bottom plate in positions marked *S* (Fig. 13), and a good deep bed of cinders laid over the whole of the bottom plate. Holes in the plates at the sides of the pit at different levels are all connected by the pieces of channel iron at *V O* (Fig. 13), and serve to carry away the vent from the bottom bed and other layers of cinders laid along the sides as ramming-up proceeds. The cinder bed is rammed firm, covered with hay, and filled in and rammed well till the depth from the top is 2 in. greater than the depth of the segment pattern.

Strips are now levelled across the pit, one at each end and one in the middle, at the depth of the pattern. The sand bed is well damped and closely



The job is now ready for the metal, 25 tons being required for runner, risers and casting. This may be poured from one ladle if there is one sufficiently large, or, if not, a 15-ton and a 10-ton ladle may be used. The stops are placed in position, and both ladles being filled the 10-ton ladle is emptied into the runner box, the stops being steadied while this is being done so that no metal shall enter the mould. The 15-ton ladle is brought up and pouring commenced, the two centre stops being removed at the same time, the other two stops being lifted as soon after as possible. As the mould fills the plates are removed from the risers, the bricks removed and feeding commenced and continued as long as the risers can be kept open.

Moulding the Rim Segments.

The moulds for the segments are made in a pit, the bottom and sides of which are lined with plates all bolted together, which form a kind of box

vented to the cinders, the vents being then closed at the upper end. Strong facing sand, mixed as below, is filled in on the vented bed to such a depth that when trodden and flat-rammed a level can be struck by a straight-edge working on the three strips previously set. For the facing sand two barrows of Red Rock sand, one barrow of horse dung, three large buckets full of coal dust, and two large shovelfuls of dry ganister are well mixed, ground for a few minutes, and passed through a ¼-in. riddle. The strips are then taken up and the bed made good where the centre strip has been, the pattern being now placed on the bed.

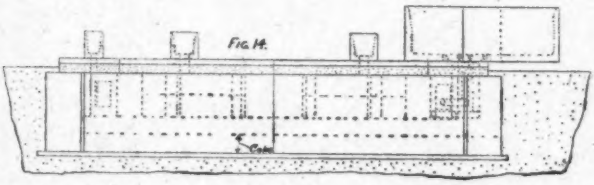
The pattern is just a plain segment with loose facings at the ends and a long print right along the outside, halfway up the pattern in sections, this print being for the cores forming the teeth used for barring purposes and shown at *T* in Fig. 1. The projections on the inside are formed by cores as shown at *P*, Fig. 13, each made in two halves and with a grid as shown in Fig. 20 The lower halves of these cores are set to marks right up to the pattern, and lie on the same level as the

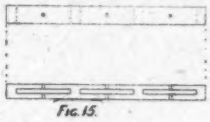
pattern. The upper halves are just laid on, and when it is seen that the joint is good, the open end is closed by flat cores carrying the bolt-hole cores.

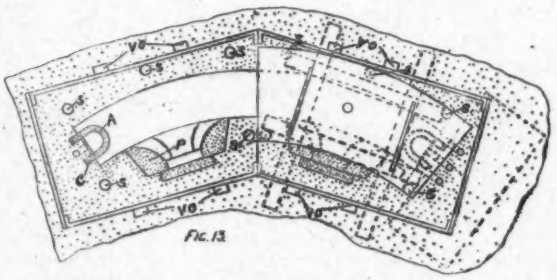
Two runner cores (Fig. 17) are set in the bed at one end close up to the pattern, and down-runners, placed on end and opposite the runner cores, are driven down about 3 in., this keeping them in place till ramming is commenced. To prevent the runner cores being forced into the mould by the flow of the metal they are secured by spikes rubbed into the sides to form grooves and then driven into the bed. The top side is covered by a thin piece of sheet iron to prevent the vent wire during venting from damaging the core. At the opposite end to the runners one of the runner cores is set in the bed and up to the pattern, and a down-runner placed at the end, as with the others, and also protected from damage by the vent wire. This is not used as a runner, but for a riser, and can be left open without doing any harm, serving to indicate when the mould has been filled with metal.

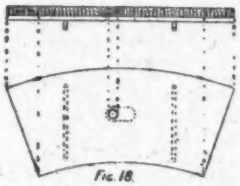
The channels are now filled level with fine ashes, also the larger channels, right to the vent outlets. The ashes round the pattern are covered with narrow pieces of sheet iron to prevent any connection with vents above. The reason for this precaution is that if the vents were continuous to the top of the mould the comparatively great length of time taken to fill the mould with metal would enable any steam generated at the bottom to travel up the vents to the top and perhaps cause the sides of the mould to strike damp and scab when the metal reached it.

The supports previously referred to and marked *S* (Fig. 13) are continued to the level of the top of the pattern, and ramming up continued as before. Before filling up for the last ram venting channels are made, vented halfway down the pattern and connected with cinders to the vent outlets. A last layer of irons is put round the pattern about an









Ramming up can now proceed in easy stages, the facing sand for the first ram and halfway up at the runner end, being the same as that used for the bed. After this the ganister is left out. Each course of sand is flat-rammed, and straight irons, about 4 in. apart and 2 in. away from the pattern, are laid all round the pattern and bedded down. After each layer of irons has been set the mould is well vented round the sides the depth of the course, the wire entering about 4 in. from the side of the pattern at an angle and going close to the pattern at its lower end.

To prevent the down-runners bursting into the mould small runner bushes are rammed up round them. When the mould is about half rammed up the screws can be removed from the long print around the outside, an extra runner placed in position between the other two and secured, and a channel made about 4 in. away from the pattern, 3 in. wide and about 2 in. deep, carried all round the job and connected by larger channels with the vent outlets *V O*, Fig. 13. These are damped and then vented all round with a three-eighths wire to the bottom of the pattern.

inch below the joint, which is then well rammed and strickled off level with the pattern, being finished off with the trowel.

The pattern is drawn, the bottom being then vented with a small wire which strikes the larger vent holes previously put in, and the whole of the mould finished. The two cores at the bottom (see *B*, Fig. 16) are set in position, there being no print, and spiked down, and the prints for the cores forming the barring teeth withdrawn, these cores fixed in and the print made good all round them. The mould is cleaned out, and a good thick coat of wet blacking applied to the mould face and sleeked while wet, any marks being washed out by a flat brush dipped in water. Fires are hung in the mould overnight, the top being covered over by pieces of sheet iron. An extra firing will no doubt be required to finish off drying, as the bottom corners and the sides will probably strike damp as the mould cools off after the first drying, due to the steam being congested in the vents and making its way to the face. The second drying will generally suffice to dry the mould far enough back to avoid the steam showing any bad effects.

The mould can now be cleaned out and the two top cores (see *A*, Fig. 16) are placed in prints made for them and held down at the ends, as shown at *C*, Fig. 13, the top face of these cores coming level with the top of the mould. These cores form a recess in which is fitted an elliptical square steel hoop for binding the ends of the segments together. At each end of the segment on the inner side is also cast a projection half elliptical in shape, which is also used for binding purposes, this projection also having a snug cast on with two bolt holes for further security in binding the segments together (see Fig. 6).

All cores being in position and the runners cleaned out, the top plates (see Fig. 18) are tried on and bear on the joint and supports *S*, Fig. 13. These plates are covered on the face side by pieces of brick bedded on coarse loam and held in place by prods cast on the plates, the whole being faced with loam. A large hole is cast in the centre so that a 6-in. riser can be formed in it for feeding purposes.

In Fig. 13 the completed mould is shown, one of the top plates being in position. Bearers, or cast-iron beams, as shown in Fig. 15, are made to bear equally along the top plates, and other bearers then laid across for securing to the links fixed on each side of the pit, previously referred to. The bearers are indicated by dotted lines in Fig. 13, and before being screwed down the space between the upper bearers and the plates forming the sides of the pit is packed to prevent any possibility of pressure on the upper edges of the mould crushing the sides in.

The risers can now be made up and closed in a similar manner to those for the half spider, the bottom riser, as we will call the one at the extreme end from the runner, being, however, just covered with hay and a brick placed over it. The joint between the two top plates and all round the edges are stopped in with black loam and a large runner box capable of holding about 10 tons of metal is placed over the runners. This runner box is lined with loam bricks as previously described, and only requires the cores, previously referred to and shown in Fig. 19, to be fitted and the sand round made good.

Practically the whole of the pit inside the plates is covered by the top plates except just opposite the cores forming the projections for the arms, and this is covered by plates and packed to the bearers above. In addition to screwing down a large weight is placed on either side of both the risers on the bearers to help to resist the great strain put on them while casting. The mould being now ready for the metal, two ladles, one holding 20 tons and the other 10 tons, are filled, the stops set in position and the smaller ladle emptied into the runner box. Fig. 14 is an elevation showing runner box, the two feeding risers, the bottom riser and the general arrangement of the mould weights and bearers. The larger ladle is brought into position and pouring commenced, the two outside stops being lifted immediately and the centre one when the mould is judged to be about half full. The cover is removed from the bottom riser, which it watched so that the caster can be warned when the mould is full and avoid straining the mould unnecessarily. When the mould is full the weights and plates over the feeding risers are removed and the metal rises in the feeding heads. Fresh hot metal is poured in these and feeding commenced and continued till the casting becomes solid, which will take about one and a half hours, fresh metal being required from time to time and the feeding rods replaced by clean ones, to be trimmed ready for use again as the others get dirty. The dimensions from Figs. 7 to 15 and 17 to 20 are indicated by Scale B. Cores *A* and *B*, shown in Fig. 16, are drawn to Scale A.

Brass Swarf and Scrap.

By an Order dated February 24, the Minister of Munitions gives notice and orders as follows:—

1. He hereby takes possession as from the 28th day of February, 1917, until further notice of :—(*a*) All yellow brass and cartridge metal swarf, turnings and borings (hereinafter referred to as "brass swarf"). (*b*) All yellow brass scrap resulting from the manufacture in any stages of any class of war material (hereinafter referred to as "brass scrap").

2. If any person having control of any metal to which this notice applies, without the consent of the Minister of Munitions sells, removes or secretes it, or deals with it in any way contrary to any conditions imposed in any licence or permit that may have been granted in respect thereof, he will be guilty of an offence against the Defence of the Realm Regulations.

3. All existing licences or permits issued by or on behalf of the Minister of Munitions for dealing in any brass swarf or brass scrap are hereby cancelled.

4. All persons shall in the first fourteen days of March, 1917, and thereafter in the first seven days of each succeeding month, send in to the Director of Materials (A.M.2.S.), Hotel Victoria, Northumberland Avenue, London, S.W., Monthly Returns of :—(*a*) All brass swarf or brass scrap held by them in stock or otherwise under their control on the last day of the preceding month. (*b*) All brass swarf or brass scrap purchased or sold by them for future delivery and not yet delivered on such last day, together with the names of the sellers to or purchasers from them.

Notwithstanding the above, no return is required from any person whose total stock of brass swarf and brass scrap in hand and on order for future delivery to him has not at any time during the preceding month exceeded 560 lbs. (5 cwt.).

5. The Minister of Munitions will subsequently communicate to the owners of brass swarf and brass scrap taken over by him the prices which he will be prepared to pay for the same.

NOTE.—(1) Notwithstanding the above Order, licences may be granted by the Minister of Munitions in approved cases for the use of brass swarf or brass scrap by producers thereof in their own works, and for the sale of any brass swarf or brass scrap which may be considered by the Minister unsuitable for his purposes.

(2) Any person acting in contravention of or failing to comply with the above Order, or making a false return, will be guilty of an offence under the Defence of the Realm Regulations, and be liable to penalties of fine and imprisonment.

The above Order does not apply to old collected miscellaneous or domestic brass scrap not arising from the manufacture of munitions.

BLAST-FURNACE PRACTICE.—A new edition of this little book, by J. J. Morgan, F.I.C., F.C.S., has been published at 2s. net by Charles Griffin & Company, Limited, Exeter Street, Strand, W.C. It is an admirable summary of blast-furnace practice, and contains much valuable information.

CASTING BRASS ON IRON.—A correspondent desires information as to the best way of casting brass on an iron screw and removing the brass easily. We have never seen this done successfully, though attempts have been made by coating the screw with oils or plumbago. We invite the opinion and experience of our readers.

The Functions of Feeders and Denseners.

(*Continued from page 91, February issue.*)

Cast Steel.

With regard to cast steel, Mr. Fraser said that foundry practice in cast steel had many features in common with that in malleable iron. There were, however, differences of detail which must be considered, namely, the high temperature at which steel was cast; the narrow range of fluidity or the rapid freezing of the steel, and the high linear contraction immediately after passing the pasty or semi-rigid state in conjunction with its lack of cohesion while in that state. The value of chillers on steel castings was almost negligible except on thin-sectioned and small, light castings. On this class of work their use was essential to economical production. The rapid freezing of the steel, however, put a short limit on the chiller's effective time of action; therefore, to get the maximum effect in the short time at disposal, the chiller must be considerably larger than if it had to produce the same effect on a malleable-iron casting. The high casting temperature caused a liability to cementation of the casting and chiller if the latter was not weighty or had any sharp projections.

Occasionally castings were required which needed treatment with feeding heads or chillers, but on which it was impossible to get feeders in the proper position, or to apply external chillers of sufficient weight to be effective. The method adopted to overcome this difficulty was to insert pieces of clean, wrought iron into the sand of the mould, allowing them to project into the section where the cooling had to be accelerated. This was a practice which could not be recommended, as the occluded gases in the pieces of wrought iron very frequently caused sponginess and blowholes in their locality.

With hot cracks, all steel founders had more than a nodding acquaintance, and probably one of the most useful functions of chillers in the casting of this metal was in reducing their frequency. The immediate cause of those cracks, which were common in even very small castings, was the resistance of the mould at its angles and projections to the inward movements of the different parts of the casting on which they were found. The cracks occurred at what, at the time of fracture, was the weakest part of the casting in the locality where the tension existed. Those weak places were found usually where there was an accumulation of heat or the thickness of the section increased. Easing the resistance of the mould to obviate this fault was, no doubt, the best method in castings of large size and weight. Also, the casting of connection or tie bars was good, although it increased the consumption of metal and added to the finishing costs; but where large numbers of castings which developed this fault were cast in a few minutes, and the crack occurred a few seconds after pouring, the first method was impossible, and the second was not economical where the castings were very light. The chiller appeared to be the best remedy in a case of this nature. It did not require to be so large as if intended to meet liquid shrinkage, as it was doing effective work until the steel in contact was at the end of the semi-rigid state.

The feeding head was an essential feature on all steel castings of weight, and in nothing did the skill and experience of the foundryman show to greater advantage than in the comparative size of it and the casting to which it was attached. The size of the head should be regulated by the design of the casting, the position of the pouring gate, the distance to which feeding action was required and the relative temperatures of the mould and head. The position of the pouring gate should be considered with the object of finding whether the entering metal would so heat the mould in that region that a local slow cooling would ensue; also whether the stream of metal would flow for a length of time over parts which naturally retained their heat longest, and thus further retard their cooling. To some degree, the size in height of the head was controlled by the range of feeding needed. Hydrostatic pressure was required to force the viscous steel into the last of the places where cavities were likely to be formed on cooling. To avoid abnormal height, the number of heads should be increased. It must be understood, of course, that with castings which had a large surface area as compared with their bulk, such as a 1-in. square bar, the range of feeding was very limited, even with a head of unreasonable height. If the mould proper was hot and the head mould cold at casting, the head should be comparatively large, because of having to supply fluid metal to a more slowly cooled casting; but if the head mould was at a good temperature a much smaller one could be used. The shape of the head was probably the greatest factor in its efficiency; large surface area was its greatest enemy. Every effort should be made to keep it as compact as possible. A fairly deep rectangular form had been found to give excellent results.

With heads which were correct in size, form and all other essentials, their power for good was often destroyed by the means employed to attach them to the casting. The centre of the body of the head should be as nearly as possible immediately over the inlet to the casting; the bottom of the head should also be as close to the casting as was compatible with a perfect mould, and affording reasonable facilities for severing the head from it. If those conditions were complied with, the connection between the two was short and compact, and was kept open until the casting's demand for metal had been satisfied by reason of these heavy bodies of metal being close together. If those two bodies of metal were kept further separate a connection of much larger sectional area was required; otherwise, strangulation took place, and the large head was rendered useless.

Experiments with Permanent Moulds.

Mr. E. H. Broughall (Coventry) gave the results of some important tests which had been recently carried out in Messrs. Herbert's Edgwick foundry for the purpose of making a definite comparison between grey iron cast in sand moulds and grey iron cast in permanent moulds. In carrying out these tests, three sets of test bars were used, and the whole of the test bars were cast from the same ladle of metal and as quickly as possible so as to ensure there being no very great change in temperature. The sand-cast bars were made in ordinary green-sand moulds and the permanent mould used was of suitable design and made of ordinary grey iron. The mixture used was quite an ordinary one, that which they continually used in the production of small parts for machine tools.

In this instance it was made up of 6 cwt. Stanton No. 3 pig-iron and 2 cwt. No. 1 Barrow hematite pig-iron. The three sets of bars comprised:—(1) Bars cast in sand moulds; (2) bars cast in permanent iron moulds but not annealed; (3) bars cast in permanent iron moulds and annealed. Chemical analyses were taken; transverse, tensile, Brinell, and Keep's tests were made, and micro-photographs of each set of bars were taken. The transverse bars for the sand-cast samples were cast 1¼ in. square by 14 in. long, and were machined to exactly 1 in. square and supported at 12-in. centres during the tests. The tensile bars for the sand-cast samples were cast 1¼ in. diameter by 9 in. long, and machined suitable for a standard tensile test bar. The bars for the tests of metal cast in permanent iron moulds were made from sticks 1½ in. dia. by 4 ft. long, and the annealed bars cast in permanent moulds were annealed at a temperature of 800 deg. to 900 deg. C. for 20 hours.

As regards the transverse tests, it was found that the bars cast in sand gave a breaking load of 22½ cwt. with a deflection of 0.130 in. The bars cast in the permanent mould and not annealed gave a breaking load of 23¼ cwt. with a deflection of 0.110 in., this being a slightly higher breaking strain but with less deflection than in the case of a sand-cast bar. The bars cast in permanent moulds and annealed gave a breaking load of 27⅜th hundredweight with a deflection of 0.110 in. The sand-cast bars had a slightly greater deflection than those cast in permanent moulds, but the bar cast in the permanent moulds, and annealed stood no less than 23 per cent. higher transverse strain than the sand-cast bars. With regard to tensile tests, it was found that the sand-cast bar stood 10.5 tons per sq. in. tensile. The bar cast in the permanent mould and not annealed stood 15.36 tons per sq. in. tensile, an increased strength of 50 per cent. over the sand-cast specimen. The bar cast in a permanent mould and annealed stood 15.6 per sq. in., being slightly stronger than the unannealed bar.

Under the Brinell hardness test,the sand-cast bar gave an average hardness of 175, the bar cast in the permanent mould and not annealed gave a hardness of 269, and the bar cast in the permanent mould and annealed gave an average hardness of 193. This test was very important, indeed, as it showed the wearing qualities of the metal. The metal cast in permanent moulds, whether annealed or unannealed, was considerably harder than that cast in sand moulds, and therefore had far better wearing properties. It was interesting to note, however, that although the metal cast in permanent moulds was considerably harder than that cast in sand moulds, it was much more easily machined. This, no doubt, was due to the fact that the combined carbon was more evenly distributed in metal cast in permanent moulds. A cutting speed of 200 ft. per minute was possible with this metal. The Keep's test gave a shrinkage on a 12-in. bar ½ in. square of 0.138 in. and a chill 1-16th in. deep, showing, as he had already stated, that the metal was such as would be used for small parts of machine tools. This test, however, proved that the mixture was not altogether suitable for casting in permanent moulds, as it was most important for this purpose that a mixture which was practically non-chilling should be used. But at the present time it was very difficult to obtain in any quantity pig-iron which would give a non-chilling mixture.

The chemical analysis of the sand-cast bar was as follows:—Total carbon, 3.313 per cent.; combined carbon, 0.218 per cent.; graphitic carbon, 3.095 per cent.; silicon, 2.868 per cent.; manganese, 0.506 per cent.; sulphur, 0.057 per cent.; phosphorus, 0.990 per cent. In the bars cast in permanent moulds and not annealed it was found that the only important change which had taken place chemically was that the combined carbon had increased from 0.218 per cent. to 0.709 per cent., and that the graphitic carbon had decreased from 3.095 per cent. to 2.645 per cent. This of course was always to be expected in castings made in permanent moulds, and was due chiefly to the considerably increased rate of cooling, which to some extent prevented the carbon separating out. In the annealed bar, however, a considerable change had taken place, the combined carbon being reduced to as low as 0.013 per cent., whilst the graphitic carbon was increased to 3.300 per cent. This, of course, was accounted for by the annealing of this set of bars. But in this connection a very important thing should be noted. The graphitic carbon in the annealed bar was exceedingly high and the combined carbon very low. In a sand-cast iron this would certainly give a very coarse fracture and a very weak iron, whereas the annealed bars cast in permanent moulds were the strongest of the three sets, and had the finest fracture. This was due to the graphitic carbon in iron cast in permanent moulds being in an entirely different form from that in which it was found in iron cast in sand moulds. Instead of being in large plates it took the form of small particles very evenly distributed, and perhaps it would be more correctly described as amorphous carbon. This difference in the form of the graphite was very easily seen under the microscope. From an examination of the actual fractures taken from the three sets of bars it would be noted the great difference in structure. The fracture of the sand-cast bar was apparently coarse. The fracture of the bar-cast in permanent moulds was much finer and denser, and there was a still further improvement as regards structure of the piece cast in permanent moulds and annealed.

Now, with regard to the use of denseners and permanent moulds it must be distinctly understood tht there was an enormous difference between the use of a densener and the use of a permanent mould. The use of denseners locally simply accelerated and equalised the cooling between a thick and a thin part of a casting, preventing porous patches, and at the same time densifying the metal at that particular point. But there was something in addition to all this when a permanent mould was used. With a permanent mould was got the advantage of the densener so far as the accelerated cooling of the metal was concerned. But the most important function, to his mind, of the permanent mould was that by its use an enormous amount of compression was put on the plastic casting, due to the expansion of the casting at its recalescence point, which expansion, of course, was turned into a compressive force by the use of the permanent moulds. He did not know whether it was possible to calculate the strength of that pressure, but from his observations of castings made in permanent moulds he was satisfied that it must be enormous.

He wished it to be understood, however, that he was not suggesting that it was possible to make all sorts of castings in permanent moulds. A great deal, of course, depended on the shape of the casting required. But there were quite a number of castings used in the engineering trade which it was very difficult indeed to get sound when

made in sand moulds, but which could be made in permanent moulds without any sign of unsoundness. He thought that what he had said showed very clearly that they should not only use denseners in order to equalise the cooling between thick and thin parts of castings, but that wherever possible they should use permanent iron moulds for the production of castings which were required to be exceptionally strong and dense. He could not help thinking that this was a matter which did not get sufficient attention from foundrymen. There appeared to be a certain amount of fear about putting molten iron into iron moulds. This fear was altogether imaginary, and if sufficient care was used in the design of the permanent mould there was no reason whatever to anticipate trouble. Should the remarks he had made be the means of creating a desire on the part of any of the members to use this method of casting he and his colleagues would at all times be only too pleased to give advice, and show by actual demonstration what they themselves had been able to accomplish.

Discussion.

Mr. F. J. Cook said that in regard to grey iron they might look at the question of denseners and heads from two points of view; first, where it was necessary to overcome the effects of a bad design, and, secondly, where it was required to increase the wearing properties of the metal. As far as bad design was concerned, Mr. Howell had shown very clearly what one might expect to get when there were differences of thickness. But most of these could be dealt with by static pressure brought to bear by means of properly constructed heads. But, unfortunately, heads cost a great deal in the way of extra moulding, extra metal and cores and the cutting of the heads afterwards. Therefore it was desirable very often to use denseners instead of heads. Another illustration showing clearly the difference between good design and bad was the difference between the steel cylinder and the liner which went into it. The liner was simply a tube, and in casting it spongy places were practically unknown if proper mixtures were used; whereas everybody knew that a cylinder casting, even if not bad enough to be rejected, often contained very loosely-packed places adjacent to the thick parts. That showed that if the casting did not cool very evenly through having irregular thicknesses bad places were sure to occur. Now, those cylinders were used for high-pressure steam and high temperatures, and in such cases, where these very thick parts were in the castings, no matter how sound the castings might look, a depression appeared when the cylinders came into use with the high pressures for which they were intended. The condition of a cylinder which had been subjected to that class of work was often very remarkable. It was most essential that such troubles should be overcome by means of denseners and cores. Again, the chiller should always be clean; it was false economy to use the same chiller too many times.

Another matter referred to by Mr. Fraser was hot-cracks. Professor Carpenter had shown that iron was affected in this way by repeated heating, but he (Mr. Cook) did not agree as to this being the explanation of the trouble in the cases mentioned. He thought it was due to oxidation; the cavities got full of oxides, which when the molten metal came against them produced blow-holes. With regard to grey iron, he would again emphasise the importance of having the chiller as clean as possible. The surface should be rubbed with emery cloth to get rid not only of the blacking but also of the oxidation underneath, and then it should be rubbed with a little dry plumbago. Another thing to be carefully watched in using denseners with cylinder iron—which, of course, was very hard—was not to use iron of a chilling nature. His experience was that with a hard iron containing 1.25 per cent. of silicon and a low percentage of carbon, it was necessary to use low manganese. Otherwise a chilled surface was got which was very difficult to machine. In such cases he recommended not more than 0.4 per cent. manganese, preferably nearer 0.2 per cent. The parts adjacent, which had not been chilled, were softer. He thought the reason for it was that one of the hardening elements was phosphide eutectic. If they tried to machine such a casting they would find that in cooling a metal of that character the cooling of the primary crystals drove the mother liquor farther from the surface. These primary crystals formed the softer part of the casting. He had frequently found that they gave a lower test result by the drill method; but, in spite of that, they had much better wearing properties. He had seen the same thing in the case of a lathe-bed, to which the drill test had been applied; the lathe-bed surface had been found to be softer when cast in sand, and yet the wearing properties had been considerably increased.

Mr. H. Pemberton (Derby) took exception to one remark of Mr. Cook's with regard to design. Mr. Cook said that everybody knew about the importance of proper designing of thick and thin castings, but everybody did not know, or there would not be such abnormal designs as they had to deal with. (Mr. Cook: They ought to know.) With regard to chillers, he quite agreed with Mr. Cook that they should not be used too many times, though at the same time Mr. Broughall had spoken of a permanent mould which he could use a thousand times. There must be some action taking place upon the chiller or densener which did not take place upon the permanent mould, because after a densener had been used a few times trouble began to arise, and one began to wonder what had gone wrong. Very often the man who made the mould was blamed when the fault was due to the chiller having been used too many times. With regard to heads and risers, he had brought a small casting, a cast-iron fuse-body. Similar castings were being made in Birmingham in the form of sticks, and cast in permanent moulds. The sample he had brought was made in a sand mould. It looked quite a simple little casting, but it was not so simple to make as it looked. One was solid in the centre, with a small pipe coming from the runner, and the other had not a pipe from the runner, but had a pipe in the centre. He had brought them to show the necessity in a simple casting for gating. One would think that by just casting with a small riser they could avoid any trouble, but without feeders one did get trouble. This showed the necessity of feeding even with a simple casting unless a permanent mould was used. He believed that these castings had been made very successfully on a large scale by a Leeds firm, but, as Mr. Cook pointed out, it was rather an expense job in consequence of the metal used for the heads, which in this case, he believed, was 100 per cent. of the actual weight of metal in the dressed casting. The heads were used for holding the fuse in the lathe while it was being turned. In making these fuse bodies he had put the runner very close to the casting and used a larger head on the runner which was for the pipe of the cast-

ing. The casting had been made successfully by putting a heavy runner close to the casting with a heavy feeding head. As to the fact referred to by Mr. Cook, that parts near a chill were softer than the rest of the casting, he thought that in the first place the conductivity of the mould accelerated the cooling of the thick section, but that shortly afterwards the chiller or densener began to get red hot. This part of the casting was thus annealed again, or brought to the normal temperature of the whole casting. That was his explanation of why a casting was soft where a chiller had been used.

Mr. Hurren thought that no one in the course of the discussion had mentioned the great disadvantage of feeding-rods. An unskilled man using feeding-rods would often murder an otherwise good casting. Feeding-rods required very skilful handling and could not be left to a labourer or to a man who would leave off too soon or go on too long. To his mind, chillers offered the best solution of the problem of feeding, provided they were used judiciously. A chiller must be of correct dimensions for the part it was to chill; otherwise—he was speaking more particularly of small castings, say, up to 5 cwt.—the material would machine badly. With regard to malleable iron, chillers meant a great saving of material in the way of feeding-heads and large runners and risers. There was also to be considered the trouble of handling and remelting and the consequent loss. Unfortunately, he found that malleable ironfounders generally could only think of one thing—how large a knob they could put by the side of the casting to feed it. A chiller, in the opinion of many of them, was of no use at all. Very often, however, after they had tried chillers they became converted to that method. One of the great disadvantages of large feeders in malleable iron was that there was a great deal of grinding to be done afterwards, and that was a very frequent cause of hard spots and hard patches, and in some cases of very minute cracks radiating from the part that was ground. He agreed that where quantities had to be made permanent moulds should be used more than they were being used now. The chief disadvantage of them was that in a great many cases the annealing process was necessary, and that added to the cost. Going back to malleable iron, there was no danger of the use of chillers causing hard patches. The hot treatment or the annealing process seemed to eliminate all differences in the material; the metal taken from the chilled place and that from the part not chilled appeared to be of practically identical chemical composition and of equal hardness as determined by the Brinell test.

Mr. Parsons remarked that by the use of a permanent mould one could very often dispense altogether with feeding. Without going into the matter very fully, he found that the use of the feeding-rod interfered so seriously with the cooling down that the casting worked unevenly. He noticed that when the casting was machined they could generally see where the feeding result had been at work, and how the feeding head had operated possibly in causing a disturbance of the crystal structure. When the casting was put to actual work those disturbed points proved to be weak. By means of a permanent mould the chilling was regularly distributed, feeding was dispensed with and that particular defect was overcome.

Mr. E. N. Wright said that he would like to make a suggestion to those members who used denseners. He had found some advantage in using preferably small denseners tapering to a point put against the longer densener and so breaking the contact between the large densener and the same part of the mould. He had considerable difficulty in producing certain castings because he got cracks between the point where the sand finished and the densener began. He overcame the difficulty by putting in small denseners.

Mr. Parsons referred to a question as to castings about 12 in. dia. by 3 ft. long, with a hole 4½ in. dia. running through. To get these castings quite sound, and to stand great hydraulic pressure, he thought a solid densener would be suitable, and a few coatings of plumbago put on each time the densener was used. If a coating were not used there would be great difficulty in getting denseners to leave the casting.

Mr. Broughall said he did not believe in feeding, and preferred to use denseners wherever possible. Feeding was an operation which as a rule was very badly carried out. With regard to Mr. Wright's remark respecting using a small densener adjacent to a large one, he thought Mr. Wright's trouble was due to the use of too large a densener, and suggested that he should use a smaller one.

Mr. R. Buchanan remarked that Mr. Howell had spoken of the "mother liquor" causing cavities in the casting, "mother liquor" being understood to refer to the remaining metal after the main crystalisation had taken place at the outside of the casting and towards the cores. He would like to know whether there was any proof of that. With regard to feeding, he quite agreed that feeding should only be done as a necessary evil, and if other means could be used, such as denseners, by which solidity could be obtained without the feeding rod, they should be employed. The rod should be avoided as far as possible. There were so many men who did not know how to feed a casting properly. On the question of nails, which he heard called chills or denseners, their function was to start solidification quickly at certain points. Sometimes it was mentioned that blowing took place from those nails. One day he saw one of his men putting nicely-blued screws into the fire and he held them there until they were red. He asked the man why he did that, and he said if he did not redden them in the furnace they would blow. He asked to see the result, and every one of the castings with the blued screws in them had blown, and those which had the screws turned red were solid. It was really a question of the nature of the blue oxide.

The meeting concluded with a hearty vote of thanks to the speakers who had opened the discussions.

KEEPING METALS HOT IN THE LADLE.—When several furnaces are tapped into one ladle before pouring, the content of the ladle is apt to become too cool. The metal can be kept hot very conveniently by using an apparatus invented by M. C. A. Keller, of Paris, consisting of two electrodes which can be raised and lowered from a crane or gantry. Current passing from one electrode to the other through the contents of the ladle generates enough heat to bring the contents back to the proper pouring temperature.

THE DUPLEX AND TRIPLEX PROCESSES IN AMERICA.—According to "The Iron Age" the duplex (Bessemer-open-hearth) process has made a decided gain in 1916, and it seems probable that within a few years most of the steel made in large works will be produced by this process. Triplexing, which generally means the refining of steel made by the Bessemer and basic open-hearth in the electric furnace, is increasing for special qualities of material.

Mechanical Tests for Cast Iron.*

By F. J. Cook.

The tests usually included in engineers' specifications are so carelessly framed as to be of no practical value. Take, for instance, the usual Admiralty specification, which reads as follows:—"Test pieces are to be taken from such castings as may be considered necessary by the inspector. The minimum tensile strength is to be 11 tons per sq. in. taken on a length of not less than 2 in."—for many years the test required was 9 tons per sq. in, but of late the required breaking load has been put up to 11 tons per sq. in.

Is the test bar expected to represent and prove

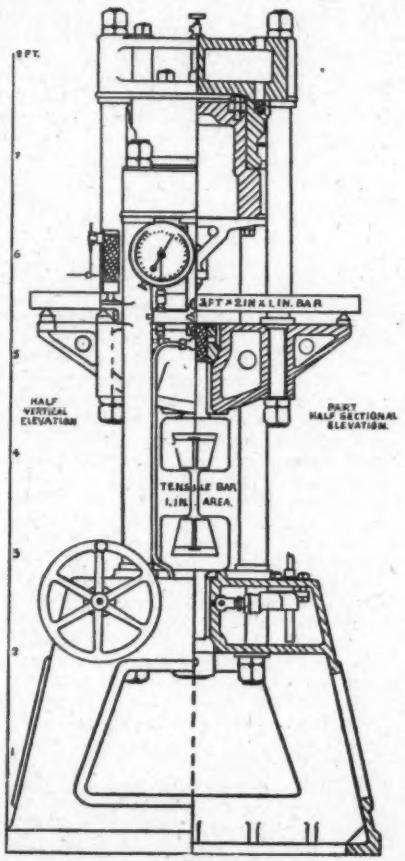


FIG. 1.

the tensile strength of a casting? If so—seeing that the specification is the same, whether the casting in question be a small cylinder say for a torpedo-boat destroyer electric lighting set, whose average thickness may be ¼ in. and weight not many pounds, or a flywheel say of 25 tons weight—it obviously leaves much to be desired. Also as initial strains due to design, etc., and rate of cooling have such a marked effect upon the relative strengths of these castings, and as they may both be cast with a metal whose composition is quite unsuitable for either of them, but which would produce a test bar which would fulfil the requirements of the specification, it is obvious that it fails to have the desired effect.

The question of test specifications for cast iron in this country is in a state of chaos, and the author considers that the time is ripe for technical associations to take the matter in hand and evolve standard rules which shall at least have the result of making tests made in various works comparative. Good work in this direction has already been done in America.

Recently the British Engineering Standards Committee issued particulars of recommended standard test bars. These, no doubt, meet the case of ductile metals, but show a want of proper appreciation for the difficulties of cast iron. No complaint can be made as to the dimensions of the test portions, but the heads and screwed parts leave much to be desired. In the pan-head type no attempt has been made to provide for the sudden change of section involving the crystallation of the metal at sharp angles in lines of weakness. The head should have a larger bearing surface so that an easier radius may be used in the corner, and so leave the strength at this portion less impaired. The underside also should be slightly bevelled to ensure the strain coming close up to the neck. In any case, pan-headed bars are not desirable for cast iron. The screwed bars are obviously unsuitable for cast iron, as the bottom of the thread is too small in comparison with the area required to be ruptured. The bars to be preferred are those which have in place of the screwed portions, corrugations with a pitch of 3-16 in. and a depth of 3-32, which with grips made to suit are admirable both for the life of grips and a fair pull on the bar, and for rough tests on unmachined bars are very convenient.

A testing machine designed by Mr. G. B. Richards, of Wednesbury, which goes a very long way to get over the difficulty of first cost and working, is shown in Fig. 1, which gives a half sectional elevation. It is a hydraulic machine, the working fluid being mineral oil. The machine is designed to carry out conveniently tensile tests of all kinds of metals, transverse tests on a 2-in. by 1-in. bar on 3-ft. centres and 1 in. square bar on 12 centres, also hardness tests and bending tests for wrought iron and steel, and is also fitted with an extremely simple extensiometer, which records the relative positions of the yield point, ultimate stress point and breaking point respectively when testing ductile materials.

The important tests which are of use as a guide to foundrymen are:—(1) Keep's tests, shrinkage, deflection and transverse; (2) hardness test; (3) casting temperature or fluidity test; (4) measurement of volume and pressure of cupola blast; (5) impact test.

Keep's test, as is now generally known, consists of casting ½-in. square bars between iron yokes, the ends of which are 12 in. apart. When the bars have cooled down the shrinkage is shown by the

* Abstract of a Paper read before the Birmingham Branch of the British Foundrymen's Association.

difference between the length of the bars and the gap in the yoke in which they were cast; this is usually measured by inserting a taper graduated wedge in the gap and measuring off the dimension of the space. This operation necessitates the bringing of the pattern plate yokes and bars into the office for measurement or *vice-versa*. To obviate this Mr. Broughall, of Messrs. Alfred Herbert, Limited, has designed a micrometer on which the bars can be measured direct without application to the yokes and wedge. This necessitates the yokes being machined to a dead length and a daily trial of the yokes with a point gauge, 0.003 in. oversize, the yokes being discarded when the point gauge will enter, which in daily practice is not often.

The shrinkage test is quite a comparative one. Although it cannot be relied upon to give a definite determination of the silicon content of the metal, under normal conditions a shrinkage of 0.183 in.= 1 per cent. silicon, and to take the other extreme 3.5 per cent. silicon is associated with 0.123 in. shrinkage. It is surprising with low-silicon irons, where one is sailing near the wind as to machinability, what a great amount of change is expressed by a variation of 0.008 in. It is obvious, then, that the test requires not only to be carefully taken but intelligently diagnosed if the best results are to be obtained.

By splitting the ends of the bars which have been cast adjacent to the yokes a good impression not only of the chilling quality of the iron, but of the way in which it backs off into the grey, is obtained. The full benefit of this test is obtained, however, by testing the bars for deflection and transverse breaking load. One of the most important points to be watched in connection with the transverse test is the deflection obtained. Unfortunately, the machines usually employed for this test are rarely fitted with any apparatus that will give a reliable result, owing to their leaving no permanent record after the bar is broken. A machine designed by Keep, for use with the 1-in. square bars previously described, is fitted with a mechanism which, giving a permanent diagram to a scale of five times the actual deflection, meets all the requirements one could wish.

The following table gives average particulars of shrinkage, deflection and breaking load obtained with various classes of iron :—

Class of material.	Shrinkage.	Deflection.	Breaking load.
	Ins.	Ins.	Lbs.
Tough strong iron ..	0.160	0.25	550
Hard " " ..	0.168	0.22	530
Soft iron..	0.123	0.18	423
Mottled iron	0.207	0.11	375
White "	0.226	0.08	250

From this it will be seen that to obtain a big deflection strong irons are necessary, whereas many believe that greatest deflection can be obtained with soft irons.

Science has so far not succeeded in formulating a satisfactory definition of the term "hardness." A most desirable test for cast iron is for its *general* hardness—not surface hardness—or rather density, which for this metal is best described by Dr. Unwin as the resistance to penetration. The most handy and reliable form of test is therefore the drill test. As this test, like many other mechanical ones, is purely comparative, it matters very little—within reasonable bounds—as to the exact methods adopted to take it, so long as they are repeated in each test.

The method adopted by the author has been to cast bars 1½ in. diameter of the metal to be tested, ⅛ in. shaped off one side to give a flat surface to work upon and remove the outside skin. Four holes ¾ in. diameter are then drilled to a depth of 1 in., the number of revolutions required to drill to this depth is noted, and the mean of the four holes is taken as indicating the general hardness. Points to be watched to obtain reliable results are, that the angle of the drill is ground exactly the same for each test drill, which is arranged for by a suitable guide on the grinding machine. The result can also be influenced by the kind of drill used; it is, therefore, essential to keep the same drill for the purpose; in fact, two drills are used and two holes drilled with each, which minimises many discrepancies which otherwise might come in. The efficiency of drills is materially affected by the sharpness of their point, and as cast iron is often not homogeneous and may contain more or less hard spots, a false result may be obtained owing to the point becoming unduly dulled by striking a hard spot in the early stages of the test. To avoid this a hole ⅛ in. diameter is first drilled, which affords clearance for the point of the drill and ensures the full cutting edge coming into operation. It is obviously necessary that the same weight be attached to the drill and also that it run at the same number of revolutions per minute for each test. Mechanism for giving a diagram is also desirable as a guide to whether abnormal hard places or hollow spaces have been encountered, both of which would give a false result.

This test represents more particularly the density of the metal, and cast-iron samples containing much more of the hardening chemical elements have given lower test results than others containing less, this being explained by the fact that the samples containing the greater amount of combined carbon and sulphur which had given low results had abnormally large crystals and larger flakes of graphite, and were therefore not so dense.

This test shows a marked relation between the hardness numeral and the relative tensile and transverse strengths of the metal. A number of tests by the author showed that the tensile and transverse results increased with the hardness up to a point and then fell away again; also that the maximum transverse test was obtained with metal a little softer than that which gave the maximum tensile result.

In connection with the Brinell hardness test, one of the objections lodged against it is the difficulty of measuring accurately the size of the indent; it undoubtedly requires very great care if accurate results are to be obtained. To avoid this the British Chuck & Piston Ring Company, of Coventry, have invented a simple and ingenious device for their own use which is easy to manipulate, and has the further advantage that the test is a mean of two specimens. Fig. 2 shows a section of the container with the two test pieces and the test ball in position; it will be seen to be so designed that the two outside faces of the test pieces are directly parallel and also that the ball is kept central. After the container has been screwed up tightly the length overall is measured by a micrometer, the whole is then put under a drop hammer, which weighs 56 lbs., and is allowed a drop of 18 ins. After the blow has been given the container is screwed up tightly to take up the indent made in the specimens and the overall length again measured, the difference between it and the previous measurement being considered the hardness numeral.

Low-silicon cast iron is very prone to the effects of casting temperature, and some irons employed for such purpose are also liable to liquid contraction. A handy workshop test for casting temperature with this class of iron, which the author has used successfully for many years, consists in making bars of the general dimensions shown in Fig. 3. When cold the bars are broken through the line A. B., the condition of the fracture giving an indication of the temperature at which the metal was poured.

Passing from the correct temperature—which is usually as hot as can be obtained from the cupola—

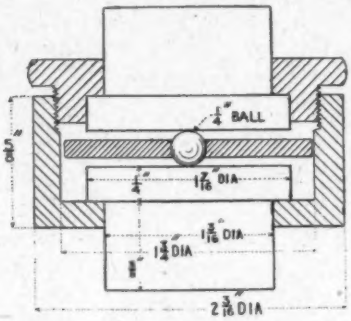


FIG. 2.

to very low, the following fractures will be observed, perfectly solid and homogeneous, then slight whitish centre, then brown centres of varying sizes and depth of colour as temperature is lowered, and then black centre; with the latter is always associated open cavities, and immediately above them is invariably found a gas hole.

Hailstone found that reduced casting temperatures resulted in larger plates and flakes of graphite, lower specific gravity, higher percentage of carbon dioxide, hydrogen and nitrogen, and a

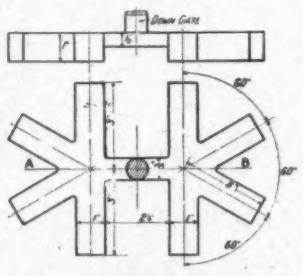


FIG. 3.

decrease in the quantity of carbon monoxide in the gas evolved.

For softer cast iron, which can be cast at a lower temperature without suffering the same effects as low-silicon irons, a test bar in the form of a wedge is a very useful guide as to the fluidity of the metal. Dimensions of such a test bar used by the British Chuck & Piston Ring Company are:—length 9 in., width 1 in., ¾ in. thick at the largest end, tapering to 1-32 at the smaller, the bars being run from the thick end.

A research to prove the effects of volume of blast upon cupola working has shown that pressure not only has an effect upon the quality of the metal but also upon the quantity melted in a given time, the following formula for most efficient working being deduced:—

$$\frac{W\sqrt{P}}{D} = 330$$

Where D=diameter of the cupola melting zone in feet. W=quantity of air in lbs. per minute. P=gauge pressure of air in ozs. In every case where high-class work requiring low-silicon iron has to be dealt with, the cupola should be fitted with a recording blast-pressure gauge, and the revolutions of the blower should be capable of variation whilst at work.

Whilst impact testing is not usually applied to cast iron, it is, however, beginning to be used, particularly on the Continent, in connection with Diesel engine work. A satisfactory test is on bars 40 mm. sq. (1.57 in.) supported on knife edges 160 mm. (6.3 in) apart, and by dropping a weight of 12 kilos (26.5 lbs.) from a height of 30 cm. (11.8 in.) increasing the height of drop by increments of 5 cm. (1.9 in.) until the sample breaks, the height at which the bar eventually fractures being taken as the impact figure. Attached to the weight, in such a manner as to strike the bar parallel to the supporting knife edges, and the centre of same, is another knife edge. All the knife edges should be rounded 1-16 in. radius. A result of 55 cm. (21.7 in.) is considered none too high for the work named, although this is quite a severe test. The maximum attained, as far as the author knows, has been 80 cm. (31.3 in.).

(For discussion see next issue.)

CORRESPONDENCE.

Light Steel Castings and Foreign Competition.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—We were very interested in your February issue, and especially in your editorial notes on light steel castings and foreign competition. Undoubtedly the Belgians have been sending steel castings into this country at a very low price, but we think we are right in saying that the quality of these castings will not compare favourably with those made by the crucible or electric processes in this country. The Belgians are fortunate in having a good local moulding sand, and this, combined with the fact that they probably pour at a lower temperature, gives their castings a very fine appearance, although it should be stated that the writer has seen steel castings made by Belgians in this country, with an English sand, which had an exceptionally good surface.

Mr. Lange's statement that Belgian foundries are better organised and equipped than English foundries is a fairly serious indictment, and details substantiating this would be very welcome.

We can offer an unqualified approval of the piecework system, which, in the hands of an intelligent ratefixer, will benefit both employers and employed.

In conclusion, we would say that the demand for light steel castings of high quality has increased enormously in the last two or three years, due to the general tightening up of specifications, and much careful thought and study must be given to the question of manufacture if we are to compete successfully with other nations.

Yours, etc.,
For Mild Steel Castings, Limited,
W. H. WATKINS (Manager).

Cast Iron.

By E. Adamson.

(*Continued from page 79, February issue.*)

Tests.

It is generally accepted that a test-bar does not represent the true strength of a casting. The position of the test-bar on the casting when cast has a great influence upon the test which will be obtained from it, as also of its being fairly representative of the strength of the casting, or otherwise. Perhaps the greatest difference which has come under my notice is that of a test-bar cast on the boss of a large propeller, which gave was undoubtedly that a test-bar cast on the boss of a propeller is severely annealed by slow cooling, and the grain of the iron at the boss is thereby considerably more open than at the blade tip.

To illustrate the difference in tests which are caused by physical conditions rather than analysis we may refer to West's tests (Table 13), which show that silicon 2.67 per cent., fracture close-grained, gives the same test in practically every instance as silicon 1.15 per cent. from open-grain iron.

Table 19.—Tensile Tests. Varying Diameters as Cast and Turned.

Numbers.		Analysis.							Diameter of test bars.		Tensiles.	
Skin on as cast.	Turned.	T.C.	G.C.	C.C.	Si.	S.	P.	Mn.	As cast.	Turned.	Average of each diameter.	Mean over all areas.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	In.	In	Tons per sq. in	Tons per sq. in.
1–3	—	3.56	2.98	0.58	1.53	0.11	1.19	0.90	1	—	12.32	—†
4–6	—	,,	,,	,,	,,	,,	,,	,,	7/8	—	12.76	—†
7–9	—	,,	,,	,,	,,	,,	,,	,,	3/4	—	12.11	—†
10–12	—	,,	,,	,,	,,	,,	,,	,,	5/8	—	13.69	12.72†
—	13–15	,,	,,	,,	,,	,,	,,	,,	—	1	Flaws	—* †
—	16–18	,,	,,	,,	,,	,,	,,	,,	—	7/8	13 20	—†
—	19–21	,,	,,	,,	,,	,,	,,	,,	—	3/4	14.72	—†
—	22–24	,,	,,	,,	,,	,,	,,	,,	—	5/8	13.96	13 96†
				Duplica ting	Tests	13 to 24						
—	40–42	3.54	2.96	0.58	1.30	0.077	0.59	0.68	—	1	13.69	—†
—	43–45	,,	,,	,,	,,	,,	,,	,,	—	7/8	15.62	—†
—	46–48	,,	,,	,,	,,	,,	,,	,,	—	3/4	15.59	—†
—	49–51	,,	,,	,,	,,	,,	,,	,,	—	5/8	15.38	15.07†

* Flaws in all bars. † From one ladle.

Table 20.—Tensile Tests with Increasing Silicons.

Mark.	Analysis							Actual silicon added.	Diameter of test bar at fracture.	Tensile strength per sq. in.	
	T.C.	G.C.	C.C.	Si	S	P.	Mn.				
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent	Inch.	All machined from 1 in. Tons.	Mean of sound bars.
16	3.56	2.98	0.58	1.53	0.11	1.19	0.90	None	1	14.03	—
17	,,	,,	,,	,,	,,	,,	,,	,,	,,	13.48*	
18	,,	,,	,,	,,	,,	,,	,,	,,	,,	—	13.75
28	3.57	3.04	0.53	1.67	0.106	1.20	0.85	0.14	,,	14.72	—
29	,,	,,	,,	,,	,,	,,	,,	,,	,,	15.31	—
30	,,	,,	,,	,,	,,	,,	,,	,,	,,	14.59	14.88
31	3.56	3.00	0.56	1.65	0.075	1.20	0.87	0.12	,,	15 38	—
32	,,	,,	,,	,,	,,	,,	,,	,,	,,	—†	
33	,,	,,	,,	,,	,,	,,	,,	,,	,,	15 48	15.44
34	3.58	2.99	0.59	1.88	0.106	1.17	0.80	0.33	,,	15.22	—
35	,,	,,	,,	,,	,,	,,	,,	,,	,,	14.54	—
36	,,	,,	,,	,,	,,	,,	,,	,,	,,	—	14.88
37	3.57	2.98	0.57	2.00	0.09	1.17	0.81	0.47	,,	—†	—
38	,,	,,	,,	,,	,,	,,	,,	,,	,,	—	
39	,,	,,	,,	,,	,,	,,	,,	,,	,,	15.47	15.47
43	3.56	2.98	0 58	1.30	0.077	0.59	0.68	None	,,	15.67	—
44	,,	,,	,,	,,	,,	,,	,,	,,	,,	15.58	—
45	,,	,,	,,	,,	,,	,,	,,	,,	,,	14.74†	15.62
52	3.59	3.05	0.54	1.46	0.073	0.84	0.65	0.16	,,	14.28	—
53	,,	,,	,,	,,	,,	,,	,,	,,	,,	14.42	—
54	,,	,,	,,	,,	,,	,,	,,	,,	,,	15 03	14.57
55	3.56	3.02	0.54	1.72	0.072	0.78	0.66	0.42	,,	14.94	—
56	,,	,,	,,	,,	,,	,,	,,	,,	,,	14.94	—
57	,,	,,	,,	,,	,,	,,	,,	,,	,,	14.04	14.64
58	3.56	3.00	0 58	1.86	0.076	0.70	0.65	0.56	,,	13.97	—
59	,,	,,	,,	,,	,,	,,	,,	,,	,,	13.78	—
60	,,	,,	,,	,,	,,	,,	,,	,,	,,	13.47	13.74

* Slight flaws † Flaw.

about 4½ tons tensile, against 11 tons usually obtained when the bars were cast separately. The reason, of course, of the low test in this instance The section of the test-bars in some cases being small, the grain of all bars would be close; hence, probably, the similar tests.

Table 20 shows that the more rapidly the test-bars are cooled—and in consequence the closer the grain—the higher the tests per square inch. A 1-in. bar gave 24.07 cwt., ¾-in. 26.33 cwt., ½-in. 28.97 cwt., ¼-in. 34.12 cwt.

Some few years ago there was a theory that tensile test-bars tested as cast with the skin on gave lowest and the highest silicon (1.53 per cent. to 2.00 per cent.), whilst the second lot showed a fall between the lowest (1.30 per cent.) and the highest (1.86 per cent.), which does not bear out the silicon control theory named in the first part of this Paper.

Fig. 4 shows the method adopted for casting and

Table 21.—Transverse Tests with Increasing Silicon.

Mark.	Analysis							Actual Percentage of silicon added	Size of test bar at fracture.		Transverse 3 ft. 0 in. centres.		Deflection.		Moment of resistance.	
	T.C.	G.C.	C.C	Si.	S.	P.	Mn.				Cwts.	Mean Cwts.	Inches.	Mean Inches.	f=	Mean
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.		Inches.	As cast.						
H.	3.56	2.98	0.58	1.53	0.110	1.19	0.90	None	2.05 × 1.050	,,	34	—	0.344	—	20.804	—
H.	,,	,,	,,	,,	,,	,,	,,	,,	2.09 × 1.040	,,	35	—	0 344	—	20.802	—
F.	,,	,,	,,	,,	,,	,,	,,	,,	2.075 × 1.100	,,	35	—	0.344	—	19.953	—
F.	,,	,,	,,	,,	,,	,,	,,	,,	2.095 × 1.100	,,	35	34.75	0.312	0.336	19.573	20.283
A.	3.56	3.03	0.53	1.65	0.098	1.19	0.85	0.12	2.15 × 1.115	,,	39	—	0.487	—	20.430	—
A.	,,	,,	,,	,,	,,	,,	,,	,,	2.11 × 1.138	,,	38	38 5	0.375	0.386	20.430	20.430
B.	3.57	3.04	0.53	1.67	0.106	1.20	0.85	0.14	2.08 × 1.098	,,	37	—	0 344	—	20.833	—
B.	,,	,,	,,	,,	,,	,,	,,	,,	2.14 × 1.140	,,	36	36.5	0.314	0.329	18.618	19.725
C.	3.56	3.00	0.56	1.65	0.075	1.20	0.87	0.12	2.11 × 1.082	,,	34	—	0.314	—	19 056	—
C.	,,	,,	,,	,,	,,	,,	,,	,,	2 092 × 1.112	,,	36	35.0	0.344	0.329	19.990	19.523
D.	3.58	2.99	0.59	1.88	0.10	1.17	0.80	0.33	2 095 × 1 072	,,	35	—	0.329	—	20 084	—
D.	,,	,,	,,	,,	,,	,,	,,	,,	2 092 × 1.090	,,	38	36.5	0.390	0.359	21.509	20.796
E.	3.57	2.98	0.57	2.00	0.09	1.17	0.81	0.47	2.086 × 1.050	,,	30	30.0	0.314	0.314	—	17.078
M.	3.56	2.98	0.58	1.30	0.077	0.59	0.68	None	2.0727 × 1.048	,,	32	—	0.329	—	19.188	—
O	,,	,,	,,	,,	,,	,,	,,	,,	2.048 × 1.052	,,	31	31.5	0.329	0.329	19.062	19.125
I.	3.59	3.05	0.54	1.46	0.073	0.84	0 65	0.16	2.057 × 1.030	,,	28	—	0 281	—	17.346	—
I.	,,	,,	,,	,,	,,	,,	,,	,,	2.071 × 1.026	,,	29	28.5	0 314	0.347	17.793	17.569
J.	3 56	3.02	0.54	1.72	0.072	0.78	0.66	0.42	2.079 × 1.036	,,	30	—	0.344	—	18 089	—
J.	,,	,,	,,	,,	,,	,,	,,	,,	2 084 × 1.028	,,	29	29.5	0.359	0.350	17.537	17.813
K	3.56	3.00	0.58	1.86	0.072	0.70	0.65	0.56	2.087 × 1.024	,,	27	—	0.314	—	16.344	—
K.	,,	,,	,,	,,	,,	,,	,,	,,	2.088 × 1.030	,,	28	27.5	0.329	0.321	16.833	16.588

a higher result than when these were turned. To prove this, I carried out a series of tests by casting twenty-four distinct test-bars from the same ladle of metal; half of these were cast to ⅞-in., ¾-in., ⅝-in. and ½-in. diameter in the centre, and the other half turned down from 1-in. bars to the same diameters. Tensiles from the turned bars were consistently higher than the others. Table 19 does not show conclusively which diameter of the turned bars gave the best result. These bars were tested with a "cup," as shown in Fig. 4.

Table 20 gives the results of an attempt to see what influence increasing silicon had in ordinary foundry mixtures. In one case, increasing the silicon by adding 50 per cent. ferro-silicon to the metal from the cupola showed a rise between the testing the tensile test-bars, so as to make sure of a perfectly straight pull.

Table 21 gives a series of transverse tests with increasing silicon. In the first instance, silicon 1.88 per cent. gave a higher transverse test than silicon 1.30 per cent., but when worked out to moment of resistance per square inch based on the exact section of the bar, there was not a wide difference.

Table 22.—Comparative Transverse Tests as Cast and as Machined.

Distinctive mark.		Analysis.							Size of bar at fracture.	Tested.	Transverse.		Deflection.		Moment of resistance per square inch.	
As cast.	Machined	T.C.	G.C.	C.C.	Si.	S.	P.	Mn.	3 ft. 0 in. centres.		Cwts	Mean Cwts.	Inches	Mean Inches	f Tons.	Mean Tons
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.								
F.	—	3.56	2 98	0 58	1.53	0.110	1.19	0.90	2.05 × 1.05	As cast	34	—	0.344	—	20.804	—
F.	—	,,	,,	,,	,,	,,	,,	,,	2.09 × 1.04	,,	35	34.5	0.344	0.344	20.802	20.803
—	G.	,,	,,	,,	,,	,,	,,	,,	2.0 × 1.0	Machined	34	—	0.437	—	22.950	—
—	G.	,,	,,	,,	,,	,,	,,	,,	2.0 × 1.0	,,	33	33.5	0.437	0.437	22.275	22.612
H.	—	,,	,,	,,	,,	,,	,,	,,	2.075 × 1.10	As cast	35	—	0.344	—	19.953	—
H.	—	,,	,,	,,	,,	,,	,,	,,	2.095 × 1.10	,,	35	35.0	0 312	0.327	19 573	19.763
M.	—	3.54	2.98	0.56	1.30	0.079	0.59	0.68	2.0727 × 1.048	As cast	32	—	0.327	—	19.188	—
O.	—	,,	,,	,,	,,	,,	,,	,,	1.052 × 2.043	,,	31	31.5	0.327	0.327	19.062	19.125
—	L.	,,	,,	,,	,,	,,	,,	,,	1.868 × 0.873	Machined	24	—	0.375	—	21.273	—
—	N.	,,	,,	,,	,,	,,	,,	,,	1.8685 × 0.880	,,	26	25.0	0.468	0.421	22.862	22.067
G.	—	3.71	3.05	0.64	1.34	0.09	1.12	0.60	2.043 × 1.082	As cast	35	—	0.352	—	20.09	—
G.	—	,,	,,	,,	,,	,,	,,	,,	2.081 × 1.072	,,	34	—	0.305	—	19.8	—
G.	—	,,	,,	,,	,,	,,	,,	,,	2.078 × 1.080	,,	33	34.0	0.328	0.328	19.1	19.9
—	G.	,,	,,	,,	,,	,,	,,	,,	2.0 × 1.0	Machined	—	34.0	—	0.461	—	22.9

The second trial showed the reverse of the above, i.e., that silicon 1.30 per cent. gave a higher transverse test than 1.86 per cent., which is again not in accordance with the theory of silicon control.

Table 22 shows that the machined transverse bars give better tests than bars tested as cast, both as regards transverse and deflection tests—particularly the latter—and the results are more marked

when worked out to moment of resistance. This has also killed some theories, and is proved correct in regular foundry practice.

Table 23 suggests that 2-in. by 1-in. transverse same ladle at different temperatures. As the temperatures recorded by the pyrometer were not satisfactory, periods of time with five minutes' interval were taken, and this clearly shows that the

Table 23.—Transverse Tests from Same Ladle under Different Conditions of Labour.

		Metal from one ladle.							Transverse 2 in. ×1 in. ×3 ft. centres.		Deflection.		Moment of resistance.	
		T.C.	G.C.	C.C.	Si.	S.	P.	Mn.	Cwts	Mean Cwts.	Inches.	Mean Inches.	Tons.	Mean Tons.
		Per cent	Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent.						
F.	*a*	3.71	3.05	0.66	1.34	0.09	1.12	0.60	35	—	0.344	—	21.1	—*
	b	—	—	—	—	—	—	—	28	—	0.258	—	17.0	—*
	c	—	—	—	—	—	—	—	28	30.33	0.266	0 289	18.5	18.9*
	d	—	—	—	—	—	—	—	—	—	—	—	—	—†
G	*a*	—	—	0.64	—	—	—	—	35	—	0.352	—	20.9	—‡
	b	—	—	—	—	—	—	—	34	—	0 302	—	19.8	—‡
	c	—	—	—	—	—	—	—	33	34.00	0.328	0.327	19.1	19.9‡
	d	—	—	—	—	—	—	—	—	34 0	—	0.461	—	29.98
H.	*a*	—	—	0.63	—	—	—	—	34	—	0.312	—	19.9	—‖
	b	—	—	—	—	—	—	—	31	—	0.336	—	19.5	—‖
	c	—	—	—	—	—	—	—	30	31.66	0.297	0 315	19.2	19.5‖
	d	—	—	—	—	—	—	—	—	—	—	—	—	—

* Tested as cast. Cast flat, with no inclination. † Machined bar, unsound. Cast flat, with no inclination.
‡ Tested as cast. Cast on edge, with no inclination. § Machined bar Cast on edge, with no inclination
‖ Tested as cast. Cast on edge with an inclination of 3 in. in 3 ft. 0 in.

test-bars cast flat do not give as good results as bars cast on the edge, and such bars appear to give more regular results when cast on edge on an incline.

bars cast at the highest temperature give the highest results in each case. These bars are cast separately and the results are borne out by daily experience, and are fully confirmed by Hailstone's

Table 24.

Tensile mark.	Transverse mark.	One ladle of Iron cast at different temperatures.							Time of casting.	Tensiles.		Transverse.		Deflection.		Moment of resistance.	
		T.C.	G.C.	C.C.	Si.	S.	P.	Mn		Tons.	Mean Tons.	Cwts.	Mean Cwts.	Inches	Mean Inches	Tons.	Mean Tons.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent	P.M.								
50	—	3.76	3.10	0.66	1.30	0.114	1.14	0.54	3.40	16.19	—	—	—	—	—	—	—*
51	—	—	—	—	—	—	—	—	—	16.13	—	—	—	—	—	—	—*
52	—	—	—	—	—	—	—	—	—	16.4	—	—	—	—	—	—	—*
53	—	—	—	—	—	—	—	—	—	16 32	16.21	—	—	—	—	—	—*
—	A.	—	—	0.66	—	—	—	—	—	—	—	32	—	0.375	—	20.3	—*
—	A.	—	—	—	—	—	—	—	—	—	—	33	—	0.3125	—	20.3	—*
—	A.	—	—	—	—	—	—	—	—	—	—	33	32.66	0.344	0.343	20.6	20.4*
54	—	—	—	0.66	—	—	—	—	3.45	14.60	—	—	—	—	—	—	—†
55	—	—	—	—	—	—	—	—	—	15.17	—	—	—	—	—	—	—†
56	—	—	—	—	—	—	—	—	—	14.08	—	—	—	—	—	—	—†
57	—	—	—	—	—	—	—	—	—	15.30	14 79	—	—	—	—	—	—†
—	B.	—	—	0.66	—	—	—	—	—	—	—	32	—	0.344	—	19.6	—†
—	B.	—	—	—	—	—	—	—	—	—	—	32	—	0.344	—	20.5	—†
—	B.	—	—	—	—	—	—	—	—	—	—	29	31.00	0.352	0.347	18.47	19.52†
58	—	—	—	0.68	—	—	—	—	3.50			—	—	—	—	—	—
59	—	—	—	—	—	—	—	—	—	Not sound.		—	—	—	—	—	—‡
60	—	—	—	—	—	—	—	—	—			—	—	—	—	—	—
61	—	—	—	—	—	—	—	—	—			—	—	—	—	—	—
—	C.	—	—	0.65	—	—	—	—	—	—	—	26	—	0.281	—	16.7	—‡
—	C.	—	—	—	—	—	—	—	—	—	—	27	—	0.273	—	17.2	—‡
—	C.	—	—	—	—	—	—	—	—	—	—	31	28.00	0.320	0.291	19.1	17.7‡
62	—	—	—	0.64	—	—	—	—	3.55			—	—	—	—	—	—
63	—	—	—	—	—	—	—	—	—	Not sound.		—	—	—	—	—	—§
64	—	—	—	—	—	—	—	—	—			—	—	—	—	—	—
65	—	—	—	—	—	—	—	—	—			—	—	—	—	—	—
—	D.	—	—	—	—	—	—	—	—	—	—	30	—	0.305	—	18.3	—§
—	D.	—	—	—	—	—	—	—	—	—	—	28	—	0.281	—	17.7	—§
—	D.	—	—	—	—	—	—	—	—	—	—	28	28.66	0.297	0.294	17.7	17.9§
66	—	—	—	0.65	—	—	—	—	4.00			—	—	—	—	—	—
67	—	—	—	—	—	—	—	—	—	Not sound.		—	—	—	—	—	—§
68	—	—	—	—	—	—	—	—	—			—	—	—	—	—	—
69	—	—	—	—	—	—	—	—	—			—	—	—	—	—	—
—	E.	—	—	0.66	—	—	—	—	—	—	—	25	—	0.285	—	15.2	—§
—	E.	—	—	—	—	—	—	—	—	—	—	24	—	0.254	—	15.3	—§
—	E.	—	—	—	—	—	—	—	—	—	—	22	23.66	0.234	0.258	14.2	14.9§

* Very hot. † Fairly hot. ‡ Thick. § Very thick

Table 24 gives results of the same metal at different casting temperatures. These bars, each tensile and transverse, were cast out of the tests in his Carnegie research recently published in the "Journal of the Iron and Steel Institute."

Now with regard to a few purely physical pro-

perties of cast iron. It is assumed to be well known in foundry practice that if a No. 1 pig-iron is used for a thick casting, it is impossible to get a resulting close-grained casting, and this regardless of the percentage of silicon. The only exception to this is, if a No. 1 iron is used in a casting of very thin section—say, a stove grate—where the metal is "chilled" practically instantly, and this is the only way in which a close-grained casting can be produced from open-grained iron. Therefore, when the statement is made that open pig-iron produces open castings, it depends, as a matter of course, upon the thickness of the casting, but it is perfectly correct to say that if an open iron is melted in the cupola and cast in a similar section to the original pig, an open fracture will be produced.

Again, it sometimes happens that a pig-iron is what is known as "chilled," and the fracture is close where normally it should have been open. Conversely, therefore, if this iron is melted in the cupola and cast in the same section, it will

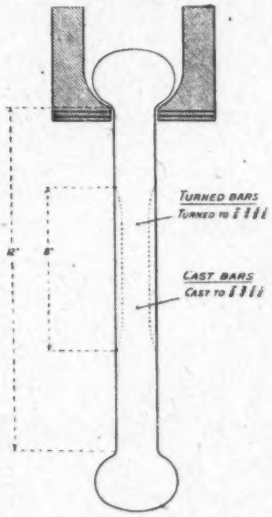


FIG. 4.

be more open than the original fracture. The most extreme instance of this came under my notice a few years ago in a Scotch foundry, where a *white* iron was being used with a close-grained iron to produce a mottled fracture in a liner, and the fracture at the gate of this liner came out more open than the grey pig-iron which was being used. Investigation proved beyond the least doubt that this was entirely due to the white iron used being a *chilled* iron, or practically a "freak" white, and when melted in the cupola—i.e., heated up to a temperature of molten metal and normally cooled—it again became grey. Such are the peculiarities of fractures, showing that they also require to be understood.

Another interesting point is the question of specific gravities of metals used in the cupola. Iron with high, if melted with another with lower, specific gravity, and if left too long in the ladle, is liable to sink to the bottom of the ladle. For example, if grey iron and white iron are melted together in the cupola, say, in equal quantities, and the molten metal left in the ladle too long before casting, the first castings poured will be grey, and the last lot mottled or white. The specific gravity of white iron is heavier than grey, and produces this phenomenon, even when the metal is molten, showing that, even if white and grey iron are melted together in the cupola, when run into the ladle there is not perfect mixing.

Exactly the same remark applies to the use of steel, with this addition—that steel melts at a very much higher temperature than cast iron, and, if used in fair quantities, does not become thoroughly mixed with the pig-iron, possibly because the temperature of the cupola is not usually sufficiently high to *melt* steel. As an instance of this, when melting certain grades of iron with steel, for experiment part was cast into a 4-in. by 4-in. pig section, and cooled rapidly in water, and I actually picked out the pieces of steel wire from the cold grey iron. Where punchings have been used, as in one foundry famous for its use of large percentages of steel, the steel which had not been properly melted came out at the top of the outlet of a large turbine casing, and jumped the tool in machining. What actually happened was: the piece of steel was in a plastic condition when it left the cupola, and was surrounded with higher carbon pig-iron, *from which it attracted by diffusion part of the carbon*, and had this steel been analysed it would have proved to have been—practically speaking—a high carbon steel embedded in and surrounded by cast iron; but the carbon in the steel, being very low for cast iron, would have been principally all combined carbon, or carbon in solid solution. Mr. Riddell dealt with this at length before the B.F.A. in Session 1912-13, when he showed very graphically how the combined carbon contents varied as it diffused into the steel.

Where close-grained castings are required to stand hydraulic pressure, it is much safer to use a pig-iron which is, in itself, *naturally* close in the grain, than to run the risk of having these difficulties.

In past years much has been written about grading by silicon contents, and it may be a fitting close to this Paper to state that in 1909 a proposal was made at the Copenhagen Congress of the International Testing Association by the United States, and a certain Continental nation, to this country to grade by silicon contents. A meeting of the representatives of the pig-iron interests in Great Britain—particularly on the practical and technical side—was called in London, and we definitely turned down the proposal. After this meeting I entered into a long correspondence with the principal American who was anxious for British works to grade by silicon, and finally he admitted in this correspondence that carbon, after all, was the controlling element.

Before the following Congress, held in New York in September, 1912, a Paper was given by J. Kail, an Austrian, which practically amounted to an attempt to prove silicon control, but all his "facts" were only statements. The following is an extract from a contribution by the present writer to the discussion on Mr. Kail's Paper:—

"Further, the fracture is an indication as to what kind of metal will be obtained in the ladle in foundry practice, and whether the castings obtained will be sound or otherwise, so that practical experience in the use of pig-iron clearly indicates the importance of fracture. The author has failed to show that his claim for silicon control will benefit the ironfounder, who is bound by specifications which are becoming more and more stringent, and by designs which are becoming more and more complicated every year. Sound castings

are now being asked for rather than high mechanical tests.

"Grading by silicon would be quite as easy for blast furnacemen as grading by fracture, but it would be considerably worse than fracture if the ironfounder relied upon silicon contents chiefly. There can be no satisfactory method of grading which ignores the physical properties of iron, as disclosed by the fracture, and governed primarily by methods of manufacture.

"Up to the present all the evidence shows that carbon is the real controlling factor in pig-iron, and this is governed entirely outside of chemical analysis by the temperature—*caloris purities*—and the methods of manufacture; otherwise by physics, a branch of chemistry, but one which is almost entirely ignored by those who favour chemical analysis."

In the discussion on the same Paper, the American authority I have already mentioned remarked, in regard to my claim that, up to the present, all evidence shows carbon is the real controlling factor in pig-iron: "There is more wisdom in this suggestion than most of us know how to handle, or to practically make use of, but it is something about which future developments will undoubtedly group themselves."

Coming from an International Congress held in the home of, and attended by, advocates of grading by analysis, this statement appears to be an indication that we have come to the parting of the ways—viz., that in the use of pig-iron, and in the manufacture of castings, we have to look further than relying upon silicon control chiefly, and all I can add is that, to an experienced man, fracture is carbon and carbon is fracture—i.e., the fracture tells the practical man the history of the manufacture of pig-iron and what conditions of carbon exist in the iron.

Earlier in this Paper it is clearly proved that some carbons will not dissolve in molten iron at temperatures commonly in use in foundry practice, and carbon separates out whilst the metal is molten. Both these points have been totally overlooked or ignored by most investigators until quite recently. There are, however, many signs of an early change.

British Foundrymen's Association.

Scottish Branch.

At a meeting of the Scottish Branch of the British Foundrymen's Association held at Glasgow on February 10, Mr. Matthew Riddell (Branch-President) in the chair, a Paper was presented by Mr. Elliot on "The Foundry and the Drawing Office; Advantages of Co-operation."

Mr. Elliot, at the outset, referred to the fact that the advance of science had made the co-ordination of the various departments in a foundry a necessity; probably because the problems associated with the casting of metals had been given better attention in scientific circles, which hitherto had not considered them. Properties were at present being demanded in castings which required the united efforts of all departments to secure them.

The natural laws set into action when a mould was cast, continued the speaker, had a considerable bearing on the strength of a casting; and as this fact was being recognised, designs of castings which hitherto did not act in unison with these laws were being remodelled on the proper lines. It was pointed out that not only was it necessary for the draughtsman to study the laws governing moulding and casting, but it was also necessary that the moulder should acquire a knowledge of drawing if a proper system of co-ordination was to be established. Every moulder should be able to read a drawing, so that he might be able to consult with the draughtsman or pattern-maker regarding some point affecting his department.

If a thorough system of co-operation of the various departments of a foundry was to be established, each department should shape the course of its work with a view to the requirements of those who followed, and embody in the work facilities, as far as possible, for alleviating the difficulties to be met with in those departments. While a draughtsman's first duty was to design a casting for its particular purpose, it is also his duty to design it in such a manner that it would give the least possible trouble to the practical departments.

A difficulty about foundry work was that while it was comparatively easy to establish a system of co-operation in departments when these departments form part of the same establishment, it was not so easy when part of the work was let out to outside makers. In some works the castings were designed and finished only, the patterns and castings being procured from outside makers. Such a system was very unsatisfactory, because there was a tendency for each department to complete its work in the cheapest manner, with no consideration for those who followed.

The lecture was followed by a general discussion, and a vote of thanks to the lecturer brought the meeting to a close.

Institute of Metals.

Programme of Annual General Meeting.

The annual general meeting of the Institute of Metals will be held in the rooms of the Chemical Society, Burlington House, Piccadilly, London, W., on March 21 and 22, commencing at 8 p.m. on the 21st and 4.30 p.m. on the 22nd. A special feature of the meeting will be a general discussion on metal melting. The following is a programme of the proceedings:—

Wednesday, March 21.

The report of the Council on the work of the past year will be presented. The Honorary Treasurer (Mr. A. E. Seaton) will present his report. The results of the ballots for the Council for 1917 and for the election of new members will be declared. A selection of Communications will be read in abstract and discussed.

Thursday, March 22.

A further selection of Communications will be read in abstract and discussed. There will be an adjournment from 6.30 to 7.45 p.m. for dinner, for which members must make their own arrangements. At 7.45 p.m. to 10 p.m. the meeting will be continued, and at the conclusion light refreshments will be provided in the Library.

Attention is particularly called to the fact that the address of the Institute has been changed to 36, Victoria Street, London, S.W., on account of Caxton House having been commandeered by the War Office.

Repetition Work and Machine Moulding.*

By A. R. Bartlett.

Specialisation in any particular branch of work is the mainspring of repetition work. When discussing repetition in the foundry the question arises as to what is the cheapest and quickest way possible of making the job successfully. Competition is the whip that drives us. This applies more particularly to light castings and small castings generally, no matter what metal they have to be cast with. Not only is the initial saving in labour in the foundry to be thought of, but the machining of the parts in the machine shop, and the assembling of the finished article in the fitting shop.

Under these conditions then, one must arrange in the first instance, wherever possible, with the draughtsman to simplify his design, and arrange with him and the pattern maker as to what taper can be allowed on the pattern, also whether it is essential to cast any particular way down on account of finished surfaces and heavy sections. The question of tests under steam, air, or water must be considered. The point must be definitely settled as to how much tooling can be allowed on finished surfaces.

The founder must endeavour to understand what the designer wants, and why the pattern maker desires to do certain things. A little consultation with him will result in the correct camber being given to a pattern which requires camber. Also they must realise that the foundryman has difficulties to contend with, and that he knows what they are and the best means of combatting and overcoming them. He may be able to suggest some alteration in design to enable him to place his runners, so that the metal does not strike against cores or projecting parts of the mould when entering; also point out the unequal thickness of metal, so the draughtsman may see his way to meet him, and thus save trouble and disappointment.

All these points are very essential, as any alteration to patterns after once being made reduces the quantity of castings that can be made in a given time, on account of the bad draw from patched patterns.

Having decided these points, the foundryman has to discover what tools are to hand that will help him make a cheap job, and get the greatest quantity out in the shortest time. It may be he has not the best machine for the class of work he has to do, and he has not the opportunity of getting what he desires. Then is the time when his initiative must come into play, and he must adapt himself and his job to the tools that he has. It may cause him to make joints in the casting that would not be necessary under favourable conditions, or it may be necessary to have cores to get overhanging parts moulded on the machine.

It does not follow that the moulding machine is the best and cheapest means of handling all repetition work. Snap-flask boxes, with pattern plates, have proved most expeditious in a large number of cases of shallow and simple work. A great advantage snap-flasks have over permanent boxes is the saving of floor space for storage, and the time saved in the subsequent knocking out and stacking with permanent boxes. One very great argument against snap-flasks is that one cannot get as many castings per box, on account of the possibility of bursting out if the box contains as many castings as can be put into permanent boxes of the same size. Again, more labour is needed to weight down snap-flasks, where with permanent boxes clamps would do; and sand must be banked round the moulds to try to prevent the possible run out. Then, again, in the case of plate work of the light type, plate moulding is contended by many to be the most satisfactory, not only in output, but in the certainty that it saves the cost of a moulding machine and the necessary power to run it.

No matter whether one is using a machine or not, it is undoubtedly true that there are advantages in using pattern plates for repetition work over using loose patterns. With the pattern plate the joint is already made, and an accurate parting is assured every time. With loose patterns the joint has to be made, and in the case of circular work or with a pattern made whole, the joint is ofttimes made in an indifferent manner, and the lift is then bad if the joint is too low; or in the case of the joint being too high, the draw is bad, thus necessitating tooling and mending, and producing indifferent casting.

With loose patterns one may very possibly make an oddside, but again the pattern plate has its advantage over this. With the pattern plate there are not the patterns to handle, as in the case of a lot of small patterns to be arranged on the oddside. Also when it becomes necessary to draw the patterns there may be a dozen or two to draw; whereas with the pattern plate all the patterns are drawn at once. In addition to this it can be well realised how efficient the draw must be with the pattern plate, seeing that it is drilled to the same jig as the boxes, and, therefore, the box pins act as a guide when lifting the pattern plate.

The oddside being, as a rule, made of plaster of Paris or wood, it gets worn out, and wants replacing, whereas with proper care the pattern plate will last for an indefinite period. The writer has never had to replace a pattern plate through being worn out, nor from being broken. Of course, a proper system and keen supervision are always necessary to get good results.

Having decided on pattern plates, no matter whether for machines or not, and knowing what boxes are to be used, the patterns must be arranged to the best advantage, so as to get the greatest number possible in the box, and the best position for runners and risers must be studied. Also must be decided which is the right way up to cast the work, how to take vents off cores if needful, and make provision for the same. Core prints should be slightly larger on all side elevations, on the top half of patterns, so that when closing the mould one has not got to rub a clearance off the cores to avoid crushing. The core-boxes must correspond accurately with the pattern, as a correctly planned job should have the cores brought straight from the core-shop and placed in the mould as soon as the mould is on the floor, without anything whatever being done to them except the vent being taken off. Tail prints to cores are advisable wherever practical, so as to

* Read before the London Branch of the British Foundrymen's Association, January 12, 1917.

avoid any stopping over, for it is usual to employ semi-skilled or unskilled labour on most plate moulding or any moulding machine. The core-making should run parallel with the moulding, otherwise there may be moulds left unclosed and not cast, taking up floor space, which while thus occupied, is not giving any return for the labour expended.

Where a large number of straight cores are required, a core-making machine should be installed, as this will give a big output at greatly reduced cost over cores made by hand.

Careful attention must be given to the efficient sifting, mixing and grinding of sand. This must be done by mechanical means where a large output is desired.

It is obvious that in the greater number of cases where small work is made from pattern plates, that the output would be much larger if made on a moulding machine than if hand moulded; not only because the machine can be worked faster, but chiefly because the drawing of the patterns, no matter what method is employed, will be more accurate. All moulders appreciate good patterns. The initial expense in making a good pattern plate is rather high, but to be really a paying proposition it must be a good one; so let us be sure that we have a sufficient quantity off the job, or prospects of repeat orders before deciding to make our plate. It used to be thought that only small work could be successfully made on pattern plates, but with the improvements in machines and methods there is no limit to the size of pattern plates nowadays. We have made a very large number of large filter-press plates and frames from pattern plates as large as 7 ft. by 4 ft., having a corrugated surface both top and bottom; both sides being exactly alike, only one half pattern was necessary. The output by the method employed gave us an increase in output from 1 per day hand moulded by three men to 6 in a day and a quarter from three men.

The method was to lift the box part from the pattern plate by means of three or four small screw-jacks. These are placed on solid foundations under the plate, and a hole is arranged in the plate to receive the head of the jack, directly under the moulding box. When the mould is rammed and ready for lifting the jacks are worked steadily and in unison, and a perfect lift is ensured. We still use this method on shallow plate work which needs a careful lift.

It is not necessary to describe the various ways, and how a pattern plate should be moulded, but it may here be stated that we find few moulders are able to make a perfect pattern plate, and it is usual to keep the same man on the job. Such men can command a higher rate of pay than the average jobbing moulder. Even with good men making pattern plates a more accurate pattern is the one that lends itself to being machined or finished as a master pattern, and then fixed to a perfectly machined surface plate.

It is imperative that the patterns be fixed, so that there shall be no movement when vibration takes place, and especially is this the case if the pattern plate is to be used on a moulding machine. If the pattern plate is to be used by the hand moulder, then it is advisable to have the plate 1 or 1½ ins. larger all round than the moulding-box, to facilitate rapping without the risk of the box being struck, and the possible loosening of the mould caused thereby. The moulder should be provided with a mallet, as a hammer or piece of iron will break pieces off the plate, and very probably crack or break it, and ruin the plate.

Another reason for advocating master patterns to be fixed to a pattern plate, in preference to being cast on, is that the cast plate often gets warped in the cooling, as the thickest part is always where the patterns are, which is obviously the centre, and the last place to cool. All foundrymen will appreciate this and know how difficult it is to avoid it, no matter how the casting is eased during cooling.

Another point to be considered, especially where large plate work is concerned, is the necessary camber required to get the ultimate casting perfect. Runners and risers often tie the casting, and cause trouble in this way. The point cannot be too strongly impressed as regards perfect pins and pin-holes. We always use a standard size of pin for each size of box. These are made of good steel, and all the holes, both in the pattern plate and boxes, are made to receive a case-hardened bush, accurately drilled, with an allowance of 0.006 in. on holes up to ¾ in., and increased slightly on larger ones.

It is infinitely better to use only two pins on all plate work, as more are likely to get out of order much quicker, and if one pin is used in the bottom box and one in the top box the box cannot be put on the wrong way round.

With work having a limited number off it is advisable to have half-patterns made, and if a number of plates are machined to fit the moulding-machine frame the patterns can be screwed on each side and removed when the order is completed, the plate then being available for use again for similar small orders. It is a mistake to think that only where hundreds of castings are needed of one type is a pattern plate justifiable.

By accurately placing a number of patterns of any type having a flat back on a pattern plate a double set of castings can be produced. Thus the pattern plate produces top and bottom moulds alike. When closing the mould it is necessary to watch how it is put together, or a "double" casting will result. This will be avoided if, as before mentioned, there is one pin in each box. Again, where the top and bottom are exactly alike the pattern on one side will suffice. These methods might aptly be termed the single-pattern process.

Another method of making pattern plates, where half the pattern is placed on one side and the other half being different on the other, may rightly be termed the double-pattern plate process.

Then there is the reversible pattern plate. Facing the one edge of the plate is the top section of the casting, and on the other edge is the bottom section; it, therefore, follows that when the mould is closed, though there are only five top half-patterns and five bottom half-patterns, ten castings are got from the box. The pattern plate can be formed somewhat like the usual oddside, the box being filled with plaster, the patterns having been accurately placed on a wooden block. This saves the expense of drilling and finishing a pattern plate in the usual way.

It is perfectly justifiable to make very large pattern plates if the order covers the initial cost, and shows an increased output per day, thus ensuring a quick delivery on which very often an order is gained, even at a higher price than a competitor's.

Multiple moulding is advocated by those who are cramped for floor space, and it is successful up to a certain extent. The work must of necessity be of a shallow nature, and can only be carried to

whatever height has been proved in each case to be the limit for efficient castings to be produced. The higher the stack is carried it is evident that the greater will be the strain on the lowest mould, and thus may produce a useless casting. To run a very high stack, hot metal is necessary, and thus an added strain is placed on the moulds. For most practical purposes six boxes high would be the limit. This again would be decided by the depth and size of the boxes used, and the class of work being made. The height of any stack should only be such that it can be easily assembled and poured, whereas a pit is needed, or staging would have to be built, to get at work piled very high.

In one system of multiple moulding the boxes are stacked each side, and one end of a permanent platform, ready for pouring, the opposite end having a slope to enable the moulder to get to the work of pouring easily.

The first attempt at mechanical moulding appears to have been the hand squeezer, which naturally only saved ramming time. The power squeezer followed, thus saving a little more time, also saving the energy of the moulder for the more delicate operations of drawing patterns and setting cores. Pattern guides, or, as we term them, stripping plates, were then devised to assist in drawing patterns accurately, and vibrators were constructed to free the pattern from the sand, without unduly enlarging the mould.

On account of the rough usage which all tools in the foundry have to stand, and the sand which is liable to get into working parts of the machine, it is advisable to consider the durability and the simplicity of the machine before installing one. The machine that will require the services of the millwright, or the tool room, in the event of its getting out of order will be an expensive tool.

If the right mixture of sand is used, the machine moulder can make a much better casting, after he has learned to use his machine, than can be produced by hand moulding. The variety of castings that can be made on the moulding machine depends greatly on the ingenuity of the foundry foreman and his opportunities of getting the patterns made in the right way. Also the indifference of the management may limit the output of a machine, or too much enthusiasm may tempt one to go beyond the bounds of possibilities. But it is safe to infer that all castings that can be made in a two-parted box can be successfully made on the moulding machine.

The advantages which modern machine moulding gives are increased output, accuracy and uniformity in shape and size; no heavy fins to chip off; the perfect fitting of the boxes and the perfect drawing of the patterns doing away with tooling and mending of the moulds, which in hand-moulding often causes bad joints and faulty castings.

The cost of trimming is greatly reduced, as machine-made castings, if placed in a rattler, need no trimming whatever, only an emery wheel being needed to grind off the projecting end of a runner or riser. We can also claim that patterns on a moulding machine will have a long life, for they are usually made of hard wood or metal, and do not get damaged by the rammer as in hand moulding, and the vent wire does not injure them, as the equal ramming given by the machine does away with venting to a great extent, and the loosening bar not being needed damage is not caused in this way.

When the conclusion has been arrived at that a moulding machine is going to be of service, the next thing to consider is what power is available, compressed air or hydraulic; also whether power is really needed. Hand machines may suffice for the work to be done. It is not essential that we think of what we might get to do, as there is nothing definite about that; but if it is known that there are prospects of work taking some definite form, then that must be considered when choosing a machine. One may have shallow work, necessitating only some simple machine, or, again, the work may be deep and intricate. No matter what type of work one may be engaged on, it will always be found that there is some machine that will lend itself particularly to that work. Again, one must consider whether the patterns will have a large amount of taper, or whether the taper will be restricted. The amount of taper often necessitates either a turnover machine or else a stripping-plate machine where the taper is slight; whereas if there is ample taper one can very often use a machine with either draw-plates or one where the boxes are lifted up or lowered down from a fixed pattern plate. Hand power machines can be readily supplied with all these fixtures, whether required to turn over or not.

On a great number of machines, even those termed power machines, hand ramming on deep work is an absolute necessity, and even on work of a medium depth, or work having small cods or pockets of sand, no machine of the squeezer type can effectively ram these parts; they must be first rammed to the necessary hardness to withstand the pressure of the metal, and then the backing sand can be successfully rammed with the squeezer or press head. The squeezer is divided into two definite types, the one in which the press head is brought down to the sand in the moulding box, and the other in which the box is fixed to the pattern table and the whole raised to the press head, which is a fixture. A machine made by a French firm is a combination of the two; it rams both top and bottom parts of the mould at the same time. The pattern frame in this instance is fixed to a swinging arm on a column, the pattern being arranged on the top and bottom of the pattern plate. This is placed in the frame and is brought between the press heads and bottom table when required. The machine is worked by hydraulic power. Behind the swing arm, attached to the column of the machine, are arranged the operating valves.

The mode of operation is to place the bottom box on the lifting table, then fill it with sand about 1½ inches above the level of the box, bring the swing arm with pattern in place over it. Then place the top box on the pattern plate, and fill with sand, as in the bottom, viz., 1½ inches above the top of the box. The operation of the valves raises the bottom box to the pattern and lowers the top head to the top box at the same time. The pressure is kept on long enough to squeeze the whole of the sand to the level of each box part. The top box is then attached to the top head. The operating valves on being reversed raise the top head with box attached, and the bottom table with the bottom box lowers. The pattern is then swung clear, and the valves being put in action again the boxes come together on their pins. The top attachment is then released, and the boxes clamped together and removed to the pouring floor. I might mention that this machine is only useful for very shallow work, but is very rapid indeed.

There are practically only three methods of drawing patterns on the moulding machine. In one the pattern is fixed and the mould is raised by means of posts attached to a frame, and operating under each corner of the box part—this would be on a non-turnover machine—and, in some instances, lowered from the fixed patterns on to a table, which is raised to receive the box—this would be on a turnover machine. In both these ways the patterns are fixed and the mould is either raised or lowered.

Another method is that in which the box part remains stationary, and the pattern is either raised or lowered, according to the type of machine. The third method is that in which the stripping plate is used and the patterns are drawn through, either upwards or downwards, the mould always remaining stationary.

There are also only three methods of ramming, viz., by hand, pressure, and jolting, or, as it is often termed jar-ramming. At first it does not appear that much saving of time can be effected on a hand-ramming machine. But when consideration is given to the fact that the patterns are drawn perfectly true, and that the mould therefore does not need tooling and patching, as in the usual jobbing moulding, it can readily be realised what a great economy is effected from this alone. The remark is often made that a hand-ramming machine is only half a machine; but four or five times the amount of work that a skilled moulder will do can be turned out per day. Therefore the increase must be due to the perfect drawing of the pattern and the saving of time effected thereby. Machines of this type are greatly in demand with founders who have no power available, as the cost of installing a compressed-air plant or hydraulic power is often prohibitive.

The pressure or squeezer method, as stated, is only useful for shallow work, or for ramming the backing sand on work partly rammed by hand, or jarring machine in some instances, where the two methods are combined.

The jar-ramming method is particularly useful for ramming deep work, and does away with the necessity for any hand ramming. For these reasons the jar-rammer is a machine of the greatest utility to the majority of founders. If the work usually done is of a general character, and not shallow all through, the jar-rammer is the machine that should never be idle, under proper supervision, while there is any work to be done.

Many will contend that there are three types of machine, viz., the squeezer, the jar-rammer, and the stripping-plate machine. But these can be sub-divided again, and we hear of roll-over or rock-over machines, shockless machines, combination jolt ram and hand and power squeezer, vibrator machines and wheel-moulding machines. Then, again, there are hand-lifting machines and power-lifting machines. These are only variations of the three first mentioned.

The squeezer type of machine, no matter whether operated by hand, hydraulic power, compressed air, electricity, steam, in the same manner as a steam hammer in the smith's shop, or by any other mechanical device, is simply a press, and it can readily be seen that the point of resistance to the press head is the nearest part of the pattern to it. From this will be seen why many press heads are shaped to suit the pattern, and thus get even pressure, both on the top and around the patterns. If a flat head is used, the parts below the level of the pattern are invariably soft, thus necessitating the hand ramming previously spoken of, before the pressure is put on.

Then, again, there is a different effect obtained on a squeezer worked by hydraulic power and one worked by compressed air, hand press or steam. The pressure given by hydraulic power is steady and continuous, as long as desired, and the same can be claimed for hand power if a hand wheel is used, but if a lever is used on a hand-power machine, the pressure is given by a series of jumps or blows, according to the number of times it is found necessary to press on the lever. The same effect is produced when using compressed air or steam, the pressure being given by blows against a fixed press head. Squeezer machines are not necessarily small machines, some machines of this type being made to take boxes 7 ft. square, and I believe in some Continental foundries even larger. But in every case it is only for comparatively shallow work.

While speaking of power, it is generally contended that hydraulic plant costs less to instal and less to maintain than does a compressed-air plant.

The jar-ramming machine is essentially a sand-packing machine. On these machines the sand is rammed by a series of jolts according to the depth of the mould ,and the amount of strain to be put upon it. It will be found that the sand is densest at the surface of the pattern and of less density above.

This is an advantage over the usual method of hand ramming or squeezing, in the fact that it aids the escape of gases when the metal is poured into the mould, and thus does away with the use of the vent wire to a great extent. All jarring machines ram on straight vertical lines, and thus it will be seen that as far as ever possible all patterns must be made to suit this tendency. Any overhanging parts, such as bosses, feet, etc., must have core prints below them to the face of the pattern plate. If this is done in the correct manner any casting can be made on a jar-rammer up to the limits of the machine as regards size.

I know of one foundry where they have another way of getting over the difficulty of ramming between overhanging parts of the pattern and the pattern plate. This is to have holes in the side of the box part just under the bosses, etc., and when the required number of jolts have been given to ram the mould the underside of bosses is rammed by hand through the hole. This is in use where aluminium is the metal poured, but I should not advocate it where other metal is poured, on account of the greater strain and the possible run out.

Jar-ramming is undoubtedly the quickest way of ramming a large mould, machines now being supplied that will ram moulds weighing 25 tons. We have in use in our foundry one that is practically never at rest, which rams absolutely perfect moulds weighing 7 tons. The machine in question is what is termed a shockless machine. It is essentially only a ramming machine, but work has been rammed on it in a few minutes that would take two men ten hours to ram by hand. This is obviously a great saving of time and energy. It does not save any of the pattern drawing or finishing time, and does not save any of the time taken in setting cores. But on large work

that we ram on it it usually reduces the cost of the job to about half what it cost previous to having the machine installed, and in many cases where there is not much finishing to be done the saving is much greater.

These machines of a smaller size are often built with a squeezer head for pressing the backing sand, which is always loose on the top of the box, whereas if not supplied the sand must be rammed either by hand or pneumatic rammer.

It will be seen what time it is possible to save by jar-ramming; and moulders know that when a large pattern is rapped with a sledge-hammer and drawn with a crane, a great deal of the moulder's time is taken up in finishing, or, to put it more bluntly, in repairing the damage done by this cruel way of rapping and drawing the pattern. The machine that has a pattern-drawing mechanism and a vibrator will save a great deal more time. Machines of this type are now to be had. On a large mould we can safely assume that at least two or three hours will be saved in this way, and most certainly the casting will be truer to the pattern than would be the case otherwise.

The term shockless when applied to the machine mentioned does not refer to the foundations on which they are built. This is the belief of many. The term is used to express the action of the machine in taking up the shock of concussion when the table on which the mould rests drops and strikes the anvil which rises at the same time. The jar is relieved between the two sections of the anvil by means of cork and rubber buffers, and the rebound is taken by the springs placed between the table and anvil and below the anvil in the base cylinder. The other type of machine, which is not shockless, has a foundation of insulating timber on which the jolt rammer works; this is placed there to relieve the shock as far as possible. This, again, is bolted to the concrete foundation proper. Thus it will be seen that all the jar is received by the ground.

The advantage of the shockless machine is that it does not shake the ground in its vicinity. In the case of the other it does, and no moulding of green-sand work or work having hanging parts can be done successfully in its immediate neighbourhood, as it is liable to get shaken to pieces and top parts are liable to fall out.

Jarring machines have been in use for many years, but have not attracted much attention till recently. It is on record that a jarring machine was patented as far back as 1869. The run of large repetition work that has arisen during the present crisis has been the cause of the installation of some new and larger types of jar-rammers.

The jar-rammer, like all other machines, began its development in a small way on small work, and has gradually extended its field of usefulness to larger and heavier moulds. On small work jarring machines cannot compete with power squeezers of the same capacity, except where the work is deep.

No matter what type of machine is installed, it is advisable, wherever possible, to ram bottom parts and top parts alternately, for in so doing the moulds can be closed at once, and if cores are to be placed in position they invariably go in the bottom part. This often saves the need of cleaning the moulds of dust and loose sand that will find its way into an open mould, and the necessary mending if anything should fall into it while waiting for the top parts. As to whether it is advisable to have a turnover machine or not depends on the work to be done.

For shallow work the non-turnover machine is the most economical, as it saves the operation of turning and the need of clamping the box to the table to turn it, these operations, of course, taking time. Even if shallow work is rammed on a turnover machine, it is not necessary to turn it, for if the patterns are made right the box should lift straight off, and thus save time. With the turnover machine the deep and more intricate work can be lowered from the pattern in a perfect condition, and work having deep internal parts, such as pulleys and boxes, is usually made on turnover machines. With the turnover machine, the mould when lowered is in the right position for placing on the floor as regards the bottom part, and this often saves the use of irons or gaggers in deep work, as there is no fear of the deep parts falling off, which is likely to happen in the non-turnover, if no irons or gaggers are used, since the work is suspended when lifted from the machine, and when turning is liable to slip sideways and fall out. As regards the top parts, it is essential that the same work be done on either type of machine, as in both instances the deep or hanging part has to be made secure to prevent falling off when placing the top half mould on the bottom.

With deep work having a small amount of taper, or spur wheels, pulleys, and tooth wheels of small or medium size, the machine that lends itself to the use of stripping-plate is the most useful. With this the pattern may be drawn either up or down through the stripping-plate, which holds the sand on the edge of the mould, thus securing a perfect lift or draw. This no doubt is an expensive machine, as every size of wheel or job must have its own stripping-plate, but knowing how difficult it is to get a perfect draw by hand when moulding a spur wheel, and how slowly a badly drawn mould is mended, and how often the casting is unsatisfactory, it is obvious that a machine for this work is very economical if there is enough work to justify the necessary outlay.

These remarks do not apply to large spur wheels, as they are usually made on a wheel moulding machine. On these machines ramming is done by hand, the setting of the teeth and the drawing of same being done mechanically in most cases. The type of tooth may be straight or helical, and flanged wheels can also be made on them. Great care has to be taken in fixing the diameters, and experience is necessary to ensure good results.

Discussion.

In opening the discussion, the CHAIRMAN (Mr. T. W. Aitken) remarked that as to the usefulness of hand-ramming machines, he had found such machines not only useful, but indispensable. Without them, for instance, louvre gratings could not be made as a marketable article. He had had occasion to instal a hand-ramming machine for making gilled radiators, and found it extremely useful. One remark of the author, however, he rather took exception to, and that was when Mr. Bartlett said that castings that can be made in a two-part box can be made successfully on a machine. He had had experience of castings of this nature that it was almost impossible to make on a machine. He referred to gas-stove fronts, the edge being 34 ins. high, about 26 ins. wide, with a depth on the front of 8½ ins., there being a uniform thickness of metal of ¼ in. Several makers of

machines had had a look at that job, but they had all given it up. That was perhaps one exception.

Mr. Bartlett, answering a question as to the less need for venting with machine ramming, said he did not contend that that was so as a general rule, because with hand-rammed work there were the same difficulties to contend with as if it was rammed on the floor in the ordinary way. With hydraulically-rammed work or jar-rammed work, a vent wire was not so necessary, because the sand had the greatest density nearest to the pattern. In jar ramming particularly, the sand solidified, and was hardest at the bottom because of the weight. A vent wire was only used to make the sand more open behind the mould to get the air out, and seeing that the sand had a lesser density above the surface of the pattern, he contended that a vent wire was not so necessary as it would be with a hand-ramming method. On one jar-ramming machine mentioned in the Paper, in which jobs up to seven tons were rammed, he never put a vent wire in, and it did not want it whether there was used green sand, dry sand or anything else. If it could be avoided a vent wire should not be used, because it damaged the pattern if it touched it and gave the man more trouble.

Mr. W. H. Aston, speaking of an experience eighteen months ago—he had only used a jar rammer a few times—said that in making cylinders 9 in. deep he had occasion to turn the box over after ramming, and in every case with the jar rammer the sand dropped out. With the same box, the same sand and an ordinary rammer the box was turned over and the thing was all right. He reasoned that if they rammed too near the pattern a smooth surface would be got, through which air would certainly not be got as with a jar rammer, because with the latter, although the particles were closer together, they were not compressed. There were spaces between the particles of sand.

Mr. Stone mentioned that with the pneumatic ramming machine first the top and then the bottom was rammed, and this necessitated two plates, and that was rather an expensive matter. He had found it better to ram the bottom on the floor and the top on the machine for the same casting. He asked if Mr. Bartlett preferred an ordinary match plate to plaster.

Mr. Bartlett said it all depended upon how much money there was to be spent. If it were repetition work he would not advocate plaster under any conditions. If it were a permanent job it would be advisable to make a proper pattern plate and not use plaster of Paris. If it were desired to do a cheap job hard wood with brass plates on each corner to give a bearing in the pattern frame would answer. It had been found, however, that the continual vibration and dampness of the atmosphere distorted the wood. Even with some very stiff battens on the backs of the boards the distortion was not avoided. In fact, the battens were pulled off, and in the end he believed these boards were more expensive than iron plates. A properly machined surface plate was much to be preferred, and for pulleys he had had one in use for thirteen years, and had never had to do anything to it. These iron plates did not get rusted or pitted, because they were not allowed to lie about. There were racks in the pattern store, and each plate was numbered, and all of that number were in that particular rack except the one in use, and this was covered with paraffin and lamp black and thus rusting was prevented.

Mr. H. G. Barrett asked Mr. Bartlett's experience with the large plate type of machine where the plate was suspended from the centre. Did the plate "dish" with continual vibration?

Mr. Bartlett said it did, but this did not arise from mechanical vibration so much as from the habit of the man to rap the plate with a mallet. The men frequently gave far too much rapping, and it did not follow that by so doing would be got a better draw.

Mr. Gaunt asked if, in the case of multiple moulds, too high a stack would cause pressure on the lower moulds and produce strain.

Mr. Bartlett said he thought it would.

Mr. Gaunt said that one gentleman, who had had much experience of multiple moulds, contended that there was not an excessive pressure on the lower moulds. His argument was that the metal set as it came up, and that pressure could not be transmitted through the metal. With regard to the hole in the box sides, as mentioned in the Paper, that might be useful for aluminium, but it might be dangerous for such metals as cast iron. In that case, why not cast lugs on the side of the box and just drop the plate down and wedge it up?

Mr. Gaunt replied that although this introduced an operation, it did away with core making.

With regard to stove fronts mentioned by the Chairman, he knew a machine that was being successfully used for these. It was designed by the firm that was using it, and in that case both presses were worked by a series of rollers on springs; the rollers came forward after the boxes were filled with sand and pressed the sand down on to the pattern. Fairly good results were being obtained when he last heard of this.

Mr. Bartlett, reverting to the question of pressure on bottom moulds of a pile, said he knew of one case where the bottom casting burst.

Mr. Gaunt said pressure could only be transmitted through a true liquid, and before the mould was full there was every possibility that the bottom part would not be a true liquid.

Mr. Bartlett said it was a question of how long the liquid remained in a liquid state. There was no great volume in the particular mould referred to, but in the case of a snap-flash mould if there was sufficient volume there would be strain. It all depended on the actual thing being made.

Answering a question as to the relative cost of hydraulic power and compressed air, Mr. Bartlett said it was contended by engineers connected with the installation of machine-moulding plants that the working cost of compressed air was the greater. The hydraulic pump did not want the attention that compressed air did. A lot of oil was required and a large amount of electricity was used because of the high speed necessary to get the amount of air to drive the machines, whereas the hydraulic pump always adjusted itself to the load and was very regular in its running. As long as the accumulator was powerful enough there would always be the necessary pressure of water. A small pump would raise a good many tons; for instance, a gill of water at each stroke would lift 30 to 40 tons. A hydraulic pump of that size could be got into a space a yard square, whereas the compressor plant would require an engine room of considerable size.

As to electric jolt and moulding machines, he had seen one at work, and the men using it were very dissatisfied because it was so very irregular in working. Personally, however, he had had no experience.

A cordial vote of thanks was accorded to Mr. Bartlett for his lecture.

Scientific Study of Refractory Materials.

Before the Sheffield Branch of the British Foundrymen's Association, on January 19, Dr. W. G. Fearnsides, M.A., Sorby Professor of Geology at Sheffield University, gave a lecture on "The Scientific Study of Refractory Materials." Mr. John Little, M.I.Mech.E., presided.

Professor Fearnsides dealt with the properties and characteristics of the silicious group of refractory materials. These owed their refractory character to the chemical properties of silica. Many rocks were found to contain up to 99 per cent. silica. Flints were found to run up to 99.7 per cent. silica. Flints were a very much neglected material in Sheffield. He knew of no one using flints in Sheffield for the purpose of getting pure silica, but there was a big firm of German kiln builders, who calcined material to very high temperatures, compared with which steel temperatures were low, who used materials made up of flints; and he knew of a silica-lined kiln which had been up for five years in which the arch had not gone.

Silica in the particular form in which it orginally crystallised slowly was a material with very strange chemical properties. Changes took place when silica was heated which were exactly analagous to the changes with which people who dealt with iron and steel were familiar. At about 870 deg. Cent. it changed in volume and density, and passed into trydinite, at which the expansion was considerably less, and slower; at about 1,470 deg. Cent. it passed into cristobalite, and at about 1,625 deg. Cent. it became vitreous silica. Cristobalite bricks at about 1,470 deg. would stand six feet high without showing signs of crushing. At 1,625 deg. they formed a liquid resembling something between treacle and pitch, but the process was a slow one, and anyone watching the furnace could get the temperature down before the bricks went. It was possible to avoid these changes by heating up quickly—it was in each case a time-temperature change, not an immediate one.

All these reasons made quartz an exceedingly valuable refractory material—it did not melt up to 1,625 deg., 100 deg. above the melting point of iron, while if one was heating up in a great hurry it could be got to melt at a lower temperature, and it demanded experience to see that that was not done, and to see that it did not get to about 1,470 without having at least some of the changes taking place. The changes were also exceedingly interesting on a falling temperature—sluggish in the changes coming down as in going up.

Professor Fearnsides emphasised the importance of the unique expansion of silica when heated. In building a furnace of bricks as received from the maker allowance had to be made for this expansion; with trydinite the allowance in the buckstays need only to be 4 per cent. instead of the 6 per cent. otherwise allowed. There was, he thought, a magnificent opportunity for the steelmen to apply themselves in the manufacture of this material. If the bottom half of the furnace happened to be made of fireclay the allowance would have to be 10 per cent. instead of 6 per cent. Taking off that amount of expansion before the construction was ever made should, he considered, help them very much.

Those calculations were, of course, based on the assumption that the silica was pure. The silicious material offered to foundry people, unless it were the sand for steel hearths, was not 99 per cent.—possibly they hoped for 97 per cent., but 95 per cent. was about what the best people should be able to put out—something between 90 per cent. and 95 per cent. was the content of most silica bricks supplied. That did not mean 90 per cent. or 95 per cent. of quartz—the silica had to be mixed with something to bind it, either a fireclay bond or a lime bond. It was found that if lime was used to bond the brick, wherever it came next the silica it would bring down the melting temperature at that point: with 25 per cent. of lime the material would become liquid at 1,420 deg.—and that was using a very pure material indeed. With 25 per cent. the melting point would rise a great deal, but trouble in another form would be experienced.

Another bond was alumina. The addition of alumina to a brick, if there were no lime present, never reduced the melting point of the mixture to below 1,610, and alumina-silica bricks had a much higher melting point than silica bricks.

From the High Peak of Derbyshire was obtainable material for bricks, the refractoriness of which was magnificent; this would stand better than any of the others. The reason was that there was no low-temperature material in their composition. Alumina brought down the melting-point 10 deg.; lime could bring it down 200 deg. There was always some material in every brick he had examined which became liquid at about 1,165 deg., but the proportion of such low-melting material required was not necessarily large.

Turning to a consideration of texture, the lecturer explained that silica bricks were made by breaking up the sandstone quartz rock or ganister into pieces and introducing some of the low-temperature materials. It was the ordinary custom to judge a silica brick on its analysis, but that, he maintained, was seriously wrong, because the strength of a silica brick was the composition of its weakest part, and not the composition of its strongest part or even of its average. The only way in which a fair notion as to whether and how much of the bad stuff was to be found in the composition was by means of a micro-section. If one took a sample of steel out of the ladle before it was poured to make an ingot, it did not follow that the weakest places in the ingot had the composition of the steel in the ladle. It was exactly the same in bricks. They judged that the steel was good by the smallness of the percentage of bad stuff, and bricks should be judged in the same way.

When a refractory material was being judged they were asked to divide the constituents into the refractory itself and its flux. Lime and alumina were its fluxes in the ordinary way. There were also always present some iron, some magnesia and some alkali. It was the custom of users to praise or damn their silica bricks by making an estimate of these fluxes, but it should be remembered that these fluxes could take the place of the alumina and lime, and that they might very well act as bond. Bricks that came into Sheffield were judged

by inspection, and sometimes condemned on account of their bad colour. It might very well be that some of the things that gave the bad colour were contained in the lime or alumina or other fluxes of which advantage had been taken, and the bricks be of first-rate quality. He had no doubt that the time was coming when good red bricks with excellent refractory properties would be on the market, and would prove to be better than the others.

What he particularly wished to emphasise, concluded the lecturer, was, first, the importance of the changes a silica brick underwent in the process of firing and the necessity of getting the makers so to fire the silica bricks and silicious material generally that the trydinite was retained; and, secondly, that flints contained in themselves a certain amount of water, and in the effect of firing for two hours above 870 deg. C.—say, for two hours at 1,000 deg.—was to bring as much change as in the case of quartz in two or three days or a week; there was got an expanded material made up from the flint in the form of silica. He believed that it might be found necessary to spend a good deal more on the making of silica bricks than by the present process; they might spend a good deal more on coal in getting the materials turned over into trydinite, for he considered that the price of the silica bricks that went into the arch of a Siemens furnace was as nothing compared with the value of getting another two weeks' or two months' work out of it before it had to be rebuilt.

Discussion.

Mr. John Little thought that a great advance would be made if only moulders and steel makers themselves knew exactly what they wanted from the brick makers, and were able to see that they got from them what they asked for. Some of the material used in the local steel works was scarcely worthy of the name of firebrick, and many a furnace collapsed after three weeks' working. He also alluded to the deleterious effects of damp and water on the bricks.

Dr. Hatfield remarked that it was urgently necessary to have a closer and more detailed appreciation of the value of science in its application to industry. Fire-brick and silica-brick manufacturers supplied an article which had perhaps met their requirements to a degree, but in America a lot of pure scientific work had been done, and obviously English manufacturers should have assimilated that knowledge and immediately applied it to their own industry. Those who had actual experience of foundry practice would at once appreciate the importance of the allotropic modifications undergone by the silica bricks. He took it that the silica which had fallen out of solution from the igneous rock during cooling was not necessarily pure silica?

Professor Fearnsides: Very nearly pure.

Dr. Hatfield added that different igneous rocks varied in composition, and therefore it was quite possible that the quartz crystals were formed with more or less percentages of other substances, and however much washing, even chemically, they might receive the silica might not run to 99.9 per cent.

Mr. F. G. Foster urged that the question of price would be a minor one with the users of silica bricks if the manufacturer would supply an article that would enable the pillars and arch and crown to stand for three years instead of eighteen months.

Mr. Goodwin said that in iron founding trouble was frequently experienced with the cupolas similar to that suffered by the steelmen. They had been content to judge their bricks by analysis—it was the only test they knew of. He had been using a lime-silica brick which was of very good appearance, but it had not got over the difficulties experienced, and if the lecturer could tell them how to use the better quality silica brick it would be much appreciated.

Mr. Watson said, in regard to steel work, his trouble was that he might get two sands which were reported upon by the chemist in practically identical terms, but which in actual working conditions behaved quite differently—one would give a beautifully clean casting and the other one upon which the stone mason would have to get to work before the casting could be found. His trouble had been to find a method whereby he could ascertain wherein one sand differed from the other.

Mr. T. Brown said he was in somewhat of the same position as Mr. Watson. He had sometimes been told that it was not possible to use the old sand over again for refractory materials. So far as he knew it was impossible, and he asked why they did not make new bricks out of the old ones?

Mr. W. J. Dawson asked if Professor Fearnsides could give the specification for making the trydinite bricks.

Professor Fearnsides, in replying to the discussion, said that in regard to the President's experience with the effect of water on the bricks, the effects were entirely different in the case of fire-bricks as compared with silica bricks. He did not think that in any case the putting of water on to things that had come out of a hot place would do them any particular good. It was not easy to exactly explain the action, but there was no doubt that water films would have the effect of opening the cracks wider and exerting stresses in one direction and then in another. There was a further action in the case of a silica brick. Every silica brick contained a certain amount of calcium silicate which was very soluble in water, and if it was stood in a wet place for a long time that soluble material would go to the bottom of the heap. It was of great importance to keep refractory materials dry. With fire-clay brick the conditions were somewhat different. The strength of a dry brick which had not been fired was made up of the layers of clay held together by the film of water between them. If a clay brick went into the kiln too wet the water boiled off when fired, and as a consequence of the bricks thus losing their strength those at the bottom lost their shape. There was no doubt that water should be kept off all fire-clay goods. In regard to the purity of silica, if present to the extent of 68 per cent. in any igneous rock it would not crystallise as silica, but would form into silicates, and the chemical composition of silica was so utterly different from that of all other silicates which were crystallising that there were found two utterly unlike bodies. It was certainly the experience of investigators that natural silica was one of the purest bodies found in nature. All over the world it did seem to separate itself from other things. The other things were destroyed, but the silica survived. In answer to a question, silica tubes, Professor Fearnsides explained, would not last for continuous use at high temperatures.

With regard to cupola practice, the trouble to which Mr. Goodwin referred was due to his using a material which was too good for the comparatively low temperatures at which they were working. He was working at a temperature below that

at which such material would become sticky—hence there was nothing in the nature of lubrication. He was using something much too good for the job. The answer was: Use something cheaper and denser for cast-iron cupolas. With regard to the binding properties of ground ganister, this was due to the fact that the particles were quite angular, and, therefore, excellent for supporting pressure, offering a large number of bearing points; ganister stuck because of the tremendous angularity of its materials, in contrast to the behaviour of pebble-like structures which acted like a bag of marbles.

The lecturer agreed that the question of moulding sands was a vital one. He could not say off-hand that the microscope would give a definite solution to the problem, but it would certainly help. The success of a moulding sand did not depend entirely upon the use of silica, for there were other properties involved, more especially that of the bond. The sand as delivered was neither of the angular character of ganister nor as little binding as a bag of marbles, at the other extreme, but was something between the two. He advised users to watch for the impurities that marred its binding qualities. As to the use of old bricks, if they were fire-bricks they were worth a great deal more than the original clay. The best German practice was to put in as much as 75 per cent. of the old bricks. There was no doubt that fire-bricks ought not to be thrown away, and, as a matter of fact, there was a firm willing to buy them, and the lecturer estimated their worth at 5s. a ton and carriage to most makers of fire-bricks. With regard to silica bricks it was a little different; with an alumina bottom they could go back with great advantage. In reply to the request for a trydinite specification, there was nobody yet making trydinite bricks. Users could make them for themselves by the operation of firing. It was found that the Deepcar bricks contained a bigger proportion of trydinite than others—by some fluke or by good management.

Gas Furnace Firing.

At a recent meeting of the Foremen's Association of the Glasgow Gas Department, Mr. John McIsaac, furnace inspector, discussed in a paper the advantages and disadvantages of the three usual systems of furnace-firing by gas—natural draft, gas at ordinary pressure and air-blast, and high-pressure gas with air at atmospheric pressure. Each of these three systems had, he contended, its particular usefulness, and the limit of application was governed by the temperature required. To understand each system thoroughly it was most essential that the limits of temperature with all three should be known. By means of a coloured chart the author showed the formation and colours of the flames from the several systems, and proceeded to state that with the natural draft system, whether the secondary air was pre-heated or not, it was impossible to guarantee definite results if the controls were neglected or difficult to judge. There was a need for further improvements in control, when using natural draft, in so far as the secondary air and draft were concerned; and further, it would tend to help matters if the burner control received more attention.

With regard to the air-blast system the author pointed out that the air-blast burner is simply a blow-pipe in which some form of obstruction is inserted near the outlet with the avowed object of obtaining a more thorough mixture of the air and gas, but the results do not justify the claim; hence the reason gas and air mixers were introduced. There are several forms of mixers in use, which are all more or less successful in so far as mixing efficiency is concerned, but the point the author wished to emphasise was the control and the means used to obtain a proper mixture for complete combustion. With most mixers it is generally left to the operator to control the proportion of air to gas by means of main control cocks, so that the success of the firing depends entirely on him. A further disadvantage is that if these control cocks are at some distance from the mixer the pressures are reduced, and may affect the results obtained; whereas if the mixture is controlled at the point of mixing any drop in pressure is less felt.

With a mixer in which the controls are embodied in the construction, so that the gas and air proportions are set at the point of mixing, and can be permanently set, making further adjustment unnecessary, all that is required is the use of main cocks at full bore each time the furnace is put in operation. With such a mixer the control of any furnace is so simple that any novice can work it and repeat any class of work without further anxiety. This must be claimed as a distinct advantage.

As regards furnaces working on high-pressure gas, the author's opinion was that great improvements in burner design, with the possibility of using lower pressures, would have to be made before they could advocate its use in preference to air-blast.

When air-blast is used all the air necessary for combustion is supplied direct to the point of combustion, and it is possible to have an excess of air; further, the flue outlets can be reduced to a minimum, as there is always a definite pressure inside the furnace, in proportion to the air pressure used. With high-pressure gas the conditions differ. The amount of gas which it is possible to consume depends entirely on the back pressure set up by the furnace, and larger flue outlets are necessary to relieve the pressure, which tends to increase the volume of waste heat, and so fixes the limits of temperature that may be obtained. In using such high pressures a special compressor of the reciprocating type must be used, which entails heavy initial expense, whereas with the air-blast the blower used is much cheaper, so that the difference in cost in many cases more than pays for the extra piping used.

The author admitted that, for many purposes, high-pressure gas was admirably suited, but for furnace work much experimenting in burner design would have to be done before it could entirely replace air-blast.

He had recently converted a large glass-annealing oven from natural draft to air-blast, using two Halkett gas and air mixers. Before the conversion the oven consumed 1,400 cub. ft. per hour, taking six hours to heat up to 600 deg. F. With the new system, using two mixers and air at ½ lb. per square inch, the gas consumption was reduced to 1,085 cub. ft. per hour for the first two hours, then down again to 900, and the temperature was finally held at 600 deg. F. for 50 per cent. less gas than the maximum used in the old system. The number of burners was reduced from 22 to 16, that is to say, each mixer supplied eight burner outlets having one control.

Foundry Problems After the War.

At a meeting of the Lancashire Branch of the British Foundrymen's Association recently, Mr. H. Sherburn in the chair, MR. M. DISLEY (Bury) delivered an address on "Foundry Problems after the War." There was not the slightest doubt, he said, that while the change in the map of Europe was taking place great events were on foot in the industrial world, many fresh problems having been created in connection with working conditions, especially in workshops and foundries. If they could only claim from the Government the same ingenuity and thoroughness in helping to create conditions to defeat our trade rivals after the war as they had shown in trying to win the war, there would be a wonderful emancipation for the employer and employé, which would make England the wonder of the age and the envy of competitive nations.

The employer would have his difficulties and problems, amongst the most important being that of the readjustment of labour conditions, the success or failure of which depended largely upon his foresight. One of the first considerations should be the creation of a right understanding between capital and labour, and in that connection he would like to quote Mr. Arthur Chamberlain's maxims for the new era after the war. To the masters he said: "Pool your brains with your competitors. The day of petty jealousy is past. You and your competitors have both to fight Germany and America. Pay a good workman the last penny he can earn. It will pay you. Win his confidence. It will be good business." To the British workman Mr. Chamberlain said: "If Britain is to beat the Hun at his own game it depends mainly on you. Put the last ounce into your work—and see that you are paid for it. The man who would take the bread out of your mouth is not the man at the next bench—it is the German workman in Germany or the Hungarian, the Swede, the Pole in America." To the master and man he said: "Do not be suspicious of one another. Make a bargain in Britain's name—and keep it." There were many of those maxims which were worthy of consideration in connection with the subject with which he was dealing.

Under existing conditions in this country they could not agree with all Mr. Chamberlain said, but some of the suggestions could be adopted, and were in fact practised now by the British Foundrymen's Association. One of the first steps must be to impress upon the employers the fact that if better provision were made in the way of necessary tools and plant it would not only be to the advantage of the worker, but would ultimately be to their own benefit. The idea that any old mill, condemned years ago, which was badly lighted and badly ventilated, or, worse than that, over ventilated so that the rain or snow came through the roof, must be dispelled. If one left the foundry for a short time, upon returning to it the blackness of the surroundings and the disorder made him wonder what he had done wrong when he was young that he was forced to eke out an existence under such conditions, with little or no hope of anything else all the days of his life. If the employer wanted the foundrymen at their best he must face that problem seriously, and see that they were placed at no disadvantage as compared with others. They knew what the employer could do when he was in earnest, because they had an example in the consideration shown for the women workers (which he did not in any way complain of) in the direction of the provision of private dressing rooms, resting places in case of overstrain, and washing utensils, thus enabling the workers to leave the foundry with a respectable appearance. Those provisions were made not because the women had to perform harder work and suffered greater mental strain than the men, but because the necessity had arisen and was met without difficulty. Why could not something be done for the men? In that respect he believed Lancashire was behind other counties, and was certainly a long way behind the Americans. There was no department in an engineering works where there was a greater need for thoughtful intelligence than in the foundry, for it was not enough to make a casting—the man had to be clever enough to anticipate the consequences of what he was doing and do it quickly. In the good old days the men who made our trade readily admitted that it was in the foundry that the greatest intelligence was required and the hardest work was done, and he hoped that when the employers were endeavouring to solve the problems of the future they would realise that, and place the moulder in his right position. The nation wanted the workmen to be at their best, and it was the employers' duty to do all in their power to help them by improving the conditions under which they laboured.

As to future employment, his (Mr. Disley's) opinion was that as far as foundries were concerned there would be plenty of work. In fact, the difficulty would be, how to get it done. Millions of tons of machinery which had been destroyed would have to be replaced, the great losses suffered by the mercantile shipping firms would necessitate constant activity in shipbuilding extending over many years, the position of the Navy would have to be maintained, and the standing Army would have to be at least as large as it was at the outbreak of war, which would mean the withdrawal of men from productive employment, because our original regular army had been almost annihilated. There was plenty of evidence of good trade; the menace was rather that of a deficiency in manpower, especially in their own particular trade. Three thousand skilled and semi-skilled men had passed from the foundry into his Majesty's forces, and already almost a thousand had fallen in the fight. In addition, it might be anticipated that another third would be claimed as victims, and then there were the disabled men who would be unable to take the place they formerly occupied in the foundry.

Another point, and it was a serious one, was that of those who had been killed or disabled the younger men and apprentices formed a vast proportion. It would be necessary, therefore, to take care of the health of the men in the foundry, for their services would be required by the nation.

A further point he wished to emphasise was that great inducements in the shape of better pay were now offered to the young men of the nation to take up positions outside the foundry, and the employers should do something to counteract that influence. The education authorities should be appealed to, because it was well known that technical schools made better provision for almost every other trade than the foundryman. If foundrymen were going to do their duty in the building up of the new industrial Empire of the world the services of every moulder would be required, and employers, instead

of discarding a man who tried his best but failed, must do their utmost to make him useful. He believed the period of three men for every job had passed. In that connection he would like to suggest that the apprentices in the foundries ought to receive more consideration. In the past they had been sadly neglected, and greater opportunities should be afforded them for becoming good all-round skilled workmen. It was not fair to impose excessively on their time in order to cheapen labour, with the result that at the end of their term they were only half trained. They were often kept too long on one particular class of work, which was not any real gain to the employer, and had a tendency to breed indifference and laziness in the youth. But the time was fast coming when the apprentice would have his time for recreation, and special facilities would be provided in the course of his working hours for improving his technical and industrial education. He wished the employers in the country could appreciate that money spent in that direction would return a much larger interest than was obtained from the present system. The great mass of the workers of to-day needed education in order to deliver them from some of the things that, in bitterness, had been burned into their nature. They were not afraid of work, and if they were given improved conditions of employment they would generously practise the maxim, "An honest day's work for an honest day's pay and we will give you good measure." They had not yet got all they deserved, as could be seen by a comparison with the conditions prevailing in America and in the Colonies, and when the worker was educated he would be able to convince his employer that he was entitled to shorter hours and better pay, and if granted those concessions would be a more valuable asset to the industry than the uneducated workman.

Discussion.

MR. HAIGH remarked that while agreeing with a great deal of what the author had said as to the necessity of improving the education of the worker, he would like to ask him how he was going to educate a man against his will. On the question of apprentices the same difficulty would have to be faced. In one foundry within fifty miles of Manchester an apprentice could leave the works any time after half-past four in order to attend evening classes and have the whole of his fees paid, and was excused from work until breakfast the following morning. Out of twenty apprentices in his own shop only four availed themselves of the opportunity, and two of those had fallen away. Clean towels and wash-basins, with a man in charge, were also provided for use as the men left the works, but for weeks on end he had never seen a dirty towel or the wash-basins used. Then a dining room was provided, but a moulder preferred to eat his meals in the foundry. Food could be handed in at the kitchen to be warmed, but he preferred to heat it over an open fireplace. It was apparent that there were employers who were anxious to meet the requirements of the men, but in many shops the moulders would not take advantage of them. If anything was to be done in that matter it would be necessary, in the first place, to educate the workers themselves. In cases of sickness a nurse was provided, but there was the utmost difficulty in getting the men to report. They could also have a nurse free of charge in maternity cases, but the men hesitated to apply, because they thought if the employer did anything he would get it back in one way or another. Of all the pessimistic views he had heard expressed of foundry life Mr. Disley's was about the worst, and the only conclusion he could form was that the foundry he had been describing was not a modern one. He agreed that moulding was a dangerous trade, but many of the accidents were due to carelessness in using the plant or failing to use the protections provided. With regard to apprentices, they all knew it was difficult to get boys to enter the foundry at 15s. a week when a chemical works offered them 30s. That was not the fault of the boy or the foundry; it was the fault of the parents, and if any improvement was to be effected in that direction the parents must be educated to the fact that it was better to apprentice a boy to a trade with 15s. a week than to place him in another occupation at 30s. a week where he would come to a dead end at twenty-one years of age.

MR. DISLEY said he recognised the difficulty in regard to the education of the worker which Mr. Haigh had mentioned, but it had to be borne in mind that the bad feeling and suspicion which existed inside the foundry had not been created in a day and could not be obliterated in a day. He was pleased to hear that there were some decent foundries, but he still maintained that nine-tenths of the so-called foundries in the outlying districts were nothing better than old mills made into workshops for a few years.

MR. MEADOWCROFT, speaking of his American experiences, said that in the States the raw material was 50 per cent. better than in this country and the sand was better, but the American moulder was not as good a workman as the English moulder. The amount of bad work he saw in the foundries there was appalling; they seemed to get the job three parts done before they found out they had started wrong. With regard to apprentices, a great step forward had been made in Manchester. Twelve months ago a trade school was started at Newton Heath, which boys of twelve or thirteen years of age could enter with a view to training in order to serve an apprenticeship to engineering. The boys were guaranteed a situation in an engineering shop, and part of their education consisted of visits to works for the purpose of seeing the practical side of the industry. After entering the foundry the boys attended the school on certain days in the week, and monthly reports were sent to the firm. At intervals the school was visited by the foremen from various shops in order to see what methods of tuition were adopted, and to make any suggestions they thought might be useful. It was a promising venture, capable of great development.

MR. PETER WALKER remarked that the workmen in the foundries should watch the apprentices and see that they were properly trained, and not kept on particular jobs for three months at a time. He agreed that in many foundries the conditions were far from satisfactory from the moulders' point of view.

MR. W. H. SHERBURN said the ideals expressed by Mr. Disley were those the Association had been endeavouring to attain since its formation. The effort to make the foundryman more self-respecting was to be commended, but the question arose, as a previous speaker had observed, How were they going to educate a man if he did not want it? Last year the Association persuaded the authorities to start classes for moulders at the School of Technology, but they proved a disappointment.

A vote of thanks was accorded Mr. Disley for his address.

Magnesium.

Facts relating to the recent developments in the American trade in magnesium and its applications in various industries are contained in a pamphlet (I : 23) compiled by MR. FRANK L. HESS, and issued by the U.S. Geological Survey. The compiler remarks that, so far as is known to the Survey, magnesium had not been produced on a commercial scale in the United States until 1915, though experiments looking toward that end had been made by various firms at different times and especially after the beginning of the war. The General Electric Company, at Schenectady, N.Y., was the first to begin active production, probably because its own needs forced it to action, and it made a steady production throughout the year. The production of the metal was also begun about August 1 by the Norton Laboratories (Inc.), first at Nashua, N.H., and later at Lockport, N.Y.; and later in the year by the Electric Production Company, New York City. The Aviation Materials Corporation, Niagara Falls, and the Magnesium Manufacturing Corporation, Rumford, Me., were ready for production at the end of 1915, but made no output. The total production during the year was 87,500 lbs., valued at about $440,000 (£88,000).

In Canada production was begun by the Shawinigan Electro-Metals Company, Limited, subsidiary to the Shawinigan Water & Power Company, at Shawinigan Falls, Quebec.

The magnesium is collected from the electrolyte, remelted, and moulded into both round and square sticks from five-eighths of an inch to 2 in. thick, and from 14 to 18 in. long. The General Electric Company sold a part of its product as a powder passing 200 mesh, for flashlights, and it sold some coarser powder for use in shells. Magnesium for flashlights must be very pure, and the company devised a process for purifying the metal. The purity usually claimed for magnesium of American production is 99.5 per cent. or more. Part of the product apparently is little if at all above 99 per cent. magnesium. It is generally accepted that the magnesium made in the States is better than that formerly imported from Germany, which is declared to have had a purity of only 98 to 99 per cent.

So far as can now be seen, any increase in the magnesium industry will depend mostly on the discovery of new profitable or desirable uses to which it may be put, and on the cost of production, but it is generally recognised that prices must fall considerably, probably to less than $1 (4s.) a pound, before peaceful uses will greatly increase. The properties of magnesium, and especially of its alloys, are not yet known well enough to say how useful the metal may be. It is claimed that extruded and other worked forms of magnesium attain a very considerable stiffness, but the subject needs further investigation. Magnesium alloys may be discovered which will be almost unchangeable, like stellite, the beautiful cobalt-chromium alloy made by Haynes.

As to any probable reduction in the cost of production, manufacturers' opinions are divided. A few operators believe that, with further easily practicable perfection of their methods, the metal can be produced for 7½d. or 10d. a pound when made in large quantities. One manufacturer, however, after careful investigation and considerable experience, believes that, although theoretical considerations make it seem possible to produce magnesium at 7½d. or even less a pound, technical difficulties will keep the cost up to several times that sum.

Before the war magnesium was quoted at about $1.65 (6s 9d.) a pound for the imported (German) material. After the cutting off of the foreign supply prices rose to $5 (£1) or even $6 (£1 4s.) a pound for sticks, and powdered material sold at $6.50 (£1 6s.) a pound; and prices remained at about these levels through the year.

Magnesium is one of the few metals of which it may be truly said that the supply of raw material —the ore—is inexhaustible. The supplies of magnesium chloride from Germany may be cut off, as they are at present, and even magnesite may become scarce, but the country has huge quantities of dolomite. Thousands of tons of magnesium carbonate are now made annually from dolomite, and should it become advisable for any reason, magnesium could be made from the same rock. Dolomites carrying 40 to 45 per cent. of magnesium carbonate, or 11.5 to 13 per cent. of magnesium, are common.

The uses of magnesium are at present neither large nor varied, and the hope for growth of the industry depends on the expansion of one or two known uses and the development of new ones. The largest use during 1915 was in the making of war munitions. It does not enter into explosives nor into arms as an integral part, but small quantities are put in shrapnel shells in order that observers and gunners may know exactly where the shells are bursting. By day the burning magnesium gives a dense pure-white cloud of magnesium oxide that can be readily and distinctly seen, and at night it gives a dazzling white light. Larger quantities are used in aerial bombs and rockets used for lighting up the country at night. A number of tons are used each year for flash-lights for photographic purposes. For this use the powder must pass a 200-mesh screen, otherwise it does not burn rapidly enough. Magnesium has not found much direct use as a metal, but magnalium—an alloy of aluminium, containing 2 per cent. or less of magnesium, and small percentages of other metals—is said to be used in automobiles and aeroplanes.

The value of magnesium as a deoxidiser is utilised by adding it to monel metal or nickel when melted for casting. It has been used in steel for the same purpose, but has so far not displaced aluminium to any large extent.

British Foundrymen's Association.

Sheffield Branch.

At a meeting of the Sheffield Branch of the British Foundrymen's Association on January 19, the following officers were elected:—President: Mr. John Little, M.I.Mech.E. (for the second year); Vice-Presidents: Mr. J. G. Crowther and Dr. Hatfield; Secretary: Mr. J. Dickinson. The members elected to fill vacancies on the Committee were:—Mr. T. Brown, Dr. Swinden, Mr. J. Watson, Mr. W. J. Dawson. The representatives to the General Council were:—Mr. T. H. Firth and Mr. J. Dickinson; Auditors: Messrs. W. H. Oxley and J. R. Hyde. The Secretary reported that at the end of the year the membership of the Branch totalled 142, as against 134 in 1915.

Constitution and Treatment of Bronzes.

"Bronze, and some of its Modifications," was the title of a paper given by Mr. F. Johnson, M.Sc., head of the Metallurgical Department of the Municipal Technical School, at a meeting of the Birmingham Local Section of the Institute of Metals, on February 13. Mr. Johnson contended that the term bronze should be confined to pure copper-tin alloys, and that alloys containing other elements should be named in such a way as to indicate their constituents. This would simplify the task of dealing with the subject. There was, for instance, manganese bronze, which in former days was a copper-tin alloy with the addition of manganese; but the term was now applied to a complex brass, which did not answer that description. The bronzes mostly in use with their proportions of copper per cent. were:—75 to 85, used for bells; 81 to 87 for bearing metals; 88 to 91, for guns; and 92 to 96 for medals and firebox stays. It was found that with the addition of tin in larger quantities, a steady fall in ductility was got. With heat treatment an increase of elongation could be obtained. With regard to tensile strength, a steady increase was got by the addition of tin up to nearly 20 per cent. Any further addition tended to reduce the tensile strength. The critical composition was with 20 per cent. of tin, when heat treatment would either bring up the tensile strength or lower it.

With a composition of 92-8 it was found that better mechanical properties could be got if the alloy were quenched at a temperature not lower than 500 deg. C. In high-quality bronzes a high quenching point tended to improve the mechanical properties. The copper-tin alloys did not to any appreciable extent occlude gases, and therefore in using them one was not troubled with porosity. That was one of the reasons why bronzes were much easier to cast brass. The bronzes were also more resistant to corrosion.

The casting properties of bronzes were generally good; there were no volatile constituents, and unless oxidation was very severe there was very little trouble in getting a sound casting, the fluidity of the bronzes being excellent.

With regard to the influence of impurities, that was, in the first place, chemical, and in the second, physical. The chemical effect was twofold, because the impurity had an influence on oxidation and also on dissolved gases. The physical effect of an impurity was of the structural or the constitutional character, generally of a constitutional character modifying the phase system. There was a difference of opinion as to the influence of arsenic. Lewis claimed that a small percentage of arsenic improved the alloy; but Rolfe, in a paper before the British Foundrymen's Association, contended that arsenic was detrimental. The latter dealt chiefly with Admiralty gunmetal, 88-10-2, which he admitted was not a pure bronze, but was sufficiently near, he thought, to serve the purpose. Antimony was much more frequent in Admiralty gunmetal than some of them suspected. But they must not be alarmed at that, because he thought that in the small quantities in which it usually occurred it had no ill effect. Owing to its cheapness, however, there was a temptation to use it to excess.

There was very little evidence of the influence of nickel on Admiralty gunmetal. Durance thought that nickels set free occluded gases and tended to produce a porous structure. But Boeddicker said that if due attention were paid to the melting point of nickel the addition of this metal had a contrary effect. The lecturer thought Boeddicker's view to be the correct one. With the addition of 1 per cent. of nickel the segregation of lead in an alloy was largely retarded, which was another point in favour of the beneficial influence of nickel. Aluminium produced shrinkage on annealing, but he thought that should not be regarded as an insuperable bar to its use. Aluminium, by increasing fluidity and in other ways, was a useful addition, but it must be used with great care, and only just sufficient to deoxidise the alloy should be added, because aluminium had a distinctly hardening and brittling tendency, and modified the structure in a very marked way.

Iron was one of those impurities which was very difficult to keep out of any non-ferrous alloy, but the small amount of iron which crept in adventitiously was not at all detrimental, though if one got free iron it, of course, gave trouble. As long ago as 1820 it was stated that a considerable amount of iron was contained in the bronze used in the Russian arsenal for making cannon. The matter was investigated by several French metallurgists, and after many years of such investigation the conclusion was formed that it would not do to add iron to gun bronzes as it decreased the fluidity and the fusibility. Durance argued that iron in bronze combined with the tin to form a harder metal. But the lecturer, in his own experiments, had not found that to be so. The iron decreased the fluidity to some extent, but had a very beneficial effect on other impurities, and acted as a strong deoxidiser.

Touching upon the ternary alloys, Mr. Johnson pointed out that any zinc that was added must take the place of the tin. In small quantities zinc acted as a deoxidiser and prevented the segregation of lead. To use large quantities of zinc in bearing metals would give a cheaper metal, but not so good, a metal with higher rate of wear and tending to galvanising of the journal and heating; in fact, worse in all such respects than a bearing metal of copper-tin-lead.

With regard to the annealing of Admiralty gunmetals, experiments showed that the maximum of elongation and tensile strength could be obtained by annealing at 700 deg. C. for half an hour.

Silicon was well known as an element to add to bronzes in which a high electrical conductivity was required, being better in that respect than phosphorus. Phosphorus was a useful deoxidising element, and was also employed for modifying the structure or altering the constitution. With regard to boron in bronze or in Admiralty gunmetal, the only conclusion he had arrived at was that it did no harm. So far he had not been able to produce any improvement in mechanical properties by the addition of boron. Arsenic in the proportion of 1 per cent. could have no detrimental effect. Antimony in the proportion of 1 per cent. greatly improved the elongation and gave an apparently tougher alloy. Manganese had a very detrimental influence on the casting qualities, but it hardened the alloys, as shown by the increased yield and the slightly lower elongation. With the addition of ferro-silicon, the commercial 25 per cent. silicon-iron alloy, was got a gunmetal which differed very little in properties from the normal gunmetal.

Trade Talk.

THE London office of Fraser & Chalmers, Limited, is now at Moorgate Hall, Finsbury Pavement, E.C.

THE export of tantalum, alloys of tantalum, and ores containing tantalum has been prohibited to all destinations.

THE CLYDEBRIDGE STEEL COMPANY, LIMITED, is being wound up voluntarily, with Mr. A. Moore, chartered accountant, Glasgow, as liquidator.

THE WHITEHEAD IRON & STEEL COMPANY, LIMITED, are about to proceed with the erection of their new steelworks near Belle Vue Park, Newport.

A RECEIVING order has been made in connection with the affairs of Mr. J. G. Redgrave, metal merchant, 130, Trafalgar Road, Moseley, Birmingham.

MESSRS. F. WAINWRIGHT and G. BUXTON, engineers, 17, Steelhouse Lane, Birmingham, trading as Wainwright & Buxton, have dissolved partnership.

CROMPTON & COMPANY, LIMITED, have appointed Mr. C. Haswell, Sherbrooke Chambers, 8, Norfolk Row, Sheffield, as their agent for Sheffield and district.

THE ANGLO ENGINEERING COMPANY, LIMITED, is being wound up voluntarily, with Mr. A. E. Tilly, 8, Staple Inn, W.C., and 27, Clement's Lane, E.C., as liquidator.

AN outbreak of fire has occurred at the Bailey Lane Works, Sheffield, of Messrs. J. & Riley Carr, manufacturers of steel, files, etc. The damage was not heavy.

MESSRS. W. TORRINGTON and J. TILLER, iron, brass, and aluminium founders and general engineers, Canal Side Foundry, Yiewsley, trading as Torrington & Tiller, have dissolved partnership.

SIEMENS BROTHERS DYNAMO WORKS, LIMITED, and Siemens Brothers & Company, Limited, have removed their offices from Caxton House, Westminster, S.W., to Palace Place Mansions, Kensington Court, London, W.

THE trustee of the sequestrated estates of A. Cohen, trading as E. Williams & Company, metal brokers, 796, Gallowgate, Glasgow, intimates that a first dividend will be paid at 168, St. Vincent Street, Glasgow, on March 10.

THE partnership heretofore subsisting between Messrs. J. Greenwood and A. W. Greenwood, carrying on business as engineers, tool makers and merchants, at Deal Street, Halifax, under the style of Greenwood Brothers, has been dissolved.

THE COPPEE COMPANY (GREAT BRITAIN), LIMITED, Kings House, Kingsway, London, W.C., have appointed Mr. J. Drummond Paton, of 25, Market Street, Manchester, as their agent for Lancashire and the north-west district.

THE business of F. Dupré & Company, iron ore and metal merchants, 27, St. Mary Axe, London, E.C., has from its formation been carried on by Mr. F. Dupré, who is the sole partner in the firm. He has decided to carry on the business in future under the name and style of F. Dupré.

ARNDT & COHN, 6, Broad Street Place, E.C., hardware importers, and the General Import and Export Company, 24, Budge Row, Cannon Street, E.C., dealers in aluminium ware, are being wound up by order of the Board of Trade.

THE estates of James White & Company, Canal Foundry, Lamb Hill, Glasgow, and J. White, ironfounder, and T. Aucott, ironfounder, the individual partners, were sequestrated on January 27 by the Sheriff of Lanarkshire, at Glasgow.

THE NORTH OF IRELAND SHIPBUILDING & ENGINEERING COMPANY, LIMITED, of Londonderry, have just taken in another stretch of ground with the object of extending their works. The addition, about four acres, gives the company a wider frontage to the river.

FIRTH, DUNLOP & RANKEN, LIMITED, iron and steel merchants, etc., of Leeds, announce that in future their business will be carried on under the title of Dunlop & Ranken, Limited. The management and conduct of the business will remain exactly as before.

THE MINISTER OF MUNITIONS announces that he has made further orders under the Munitions of War Acts, 1915 and 1916, under which 97 additional establishments have been declared controlled establishments. The total number of controlled establishments is now 4,719.

THE Secretary of the American Navy announces that the British Minister of Munitions had expressed the hope that Hadfields, Limited, would make projectiles for the American navy within 16 months. The American Government, however, have decided to build their own plant.

Draft Bills relating to the metric system of weights and measures, and the decimal system of coinage, are to be submitted to the various Chambers of Commerce throughout the country, and, if approved by them are to be introduced into Parliament in the course of the ensuing session.

THE MINISTRY OF MUNITIONS announces that all communications intended for the Machine Tool Section of the Ministry regarding "Sale" or "Wanted" advertisements for machine tools shall in future be addressed to the Director, and, under no circumstances, to individuals.

THE shareholders of the Gröndal Kjellin Company, Limited, have decided to reconstruct the company, and accordingly the company is being wound up voluntarily. Mr. G. H. Hill, 20, Abchurch Lane, London, E.C., has been appointed liquidator. The new company will be named the Gröndal Kjellin Company (1917), Limited.

THE Iron and Steel Industries Committee of the Board of Trade, 6, Whitehall Gardens, S.W., expects to have heard all the evidence which will be necessary for the completion of the inquiry within a few weeks from now. In any case, the Committee wishes to cease taking evidence by the end of March, but desires that any association or individual who may wish to give evidence shall have an adequate opportunity.

SIR W. PEARCE asked the Minister of Munitions on February 19, whether he was aware that the exchange value of lead was of great consequence to chemical manufacturers, and that in fixing the value of old lead at £26 more than double the usual difference between old and new sheet lead was established; and if prompt steps would be taken to ensure a return to the usual basis of exchange? DR. ADDISON: I am aware that the difference between the prices of old lead and new sheet lead has been greater since the fixing of the old lead price at £26 per ton net. It should be borne in mind that the manufacturers for the most part had stocks of material in hand for which a greater price than the price of £29 per ton net fixed by the Order had been paid. These stocks are now being absorbed, and the price of sheet lead has fallen considerably during the last few days. Steps will be taken shortly to fix minimum prices for manufactured lead based on those now fixed for virgin and scrap lead.

THE hearing was concluded at Sheffield, on February 2, of the series of serious charges against two scrap dealers of illegal trading in high-speed steel. The defendants, C. Stockdale and J. Skelton, were charged with receiving high-speed steel, knowing it to have been stolen, and also with offences under the Defence of Realm Act, in having high-speed steel in their possession without a permit issued under the authority of the Army Council, Admiralty, or Ministry of Munitions. Skelton was further charged with stealing 1 cwt. 48 lbs. of high-speed steel scrap, the property of the Sheffield Twist Drill and Steel Company, Limited. Stockdale was committed for trial at the Assizes, bail being allowed, defendant in £250 and two sureties of £250 each. Skelton was also committed for trial at the Assizes.

CONSIDERABLE progress is being made at Chepstow by the Standard Shipbuilding and Engineering Company, Limited. It will be remembered that last August the company took over the engineering works of Edward Finch & Company, Limited, and a new company was formed entitled Edward Finch & Company (1916), Limited. In spite of labour difficulties three slipways have been prepared in this yard, and

two 3,300 ton cargo steamers are being built. It is expected that a vessel of about 6,000 tons dead-weight will shortly be laid down on the third slip, and it is hoped that by the end of the year five new steamers will have been put into the water from this yard, in addition to a number of smaller vessels. Work in the new yard of the Standard Company is making progress, and the first four slips for building steamers up to 10,000 tons each are being prepared.

The estimated make of pig-iron at the furnaces within the port of Middlesbrough during the last ten years is appended :—

	Cleveland Iron. Tons.	Hematite, &c. Tons.	Total Tons.
1907 ..	1,494,000	820,000	2,314,000
1908 ..	1,415,000	815,000	2,230,000
1909 ..	1,375,000	757,000	2,132,000
1910 ..	1,490,000	785,000	2,275,000
1911 ..	1,510,000	785,000	2,295,000
1912 ..	1,364,000	816,000	2,180,000
1913 ..	1,566,000	1,135,000	2,701,000
1914 ..	1,307,000	1,084,000	2,391,000
1915 ..	1,095,000	1,059,000	2,154,000
1916 ..	976,000	1,331,000	2,307,000

The following table shows the blast furnaces erected and in operation at the end of each year since 1910 :—

	1910.	1911.	1912.	1913.	1914.	1915.	1916.
Built ..	80	79	77	78	77	77	77
Blowing ..	57	53	61	52	49	43	50

THERE was a large attendance at the Department of Applied Science, Sheffield University, last month, to hear a lecture by Professor Bragg, of Leeds University, on the application of X-rays for the purpose of metallurgical research. The meeting had been organised by the Sheffield Society of Engineers and Metallurgists. Professor Arnold presided. The annual meeting of the Society was held on the same occasion. Professor Arnold, after being re-elected president, spoke of the good work done by the council during the year in spite of the war. The membership now stood at 458, or only one less than a year ago. The revenue from subscriptions had increased from £193 to £241. The meeting re-elected the following officials : Secretary, Mr. E. C. Ibbotson; assistant secretary, Mr. E. J. Thackeray; members of council, Messrs. F. Best, H. Brearley, J. B. Crosby, and L. W. Willis.

THE annual report of the Machine Tool and Engineering Association, Limited, states that since the last report 24 firms have joined, while one has resigned, the membership being now 157. Several of the directors and members have given evidence before the Board of Trade Engineering Inquiry Committee, to which the directors have furnished a report on the machine tool trade, and have made certain suggestions as to the steps that will be necessary on the part of the Government to assist in further developments of the trade. In view of the decision of the railway companies that no machine tools should be carried at the companies' risk, except when packed, representations were made to the companies, and the regulation was modified so as to apply only to lathes. The railway companies were not willing for lathes to be sent at company's risk, except when packed, but in view of the importance of the matter the directors have taken counsel's opinion, and the question of further action is now under consideration.

A MEETING of the Newcastle and District Branch of the British Foundrymen's Association was held on January 27 at the Neville Hall. The president of the National Association, Mr. J. Ellis, attended, and was entertained prior to the business meeting. The chair was occupied by the local president, Mr. W. J. Paulin. The president, in the course of an address, said they hoped to secure the Royal Charter for their Association; as a matter of fact, it should have been granted long ago, for they must have spent some thousands of pounds purely on work of an educational character. He was glad to say that to-day they had some of the most eminent metallurgists amongst their members, and if the Association had done nothing else, it had done much to bring together the man of science and the practical worker. The President then presented the Association diploma to Mr. B. W. Johnston, of Sunderland, for his paper on "The Prehistoric Founder." Mr. H. J. Young, of Wallsend, then read a paper upon "The Control of Cast Iron."

THE BRITISH MOTOR CASTING SPECIALITIES, Pleasant Street Foundry, West Bromwich, have recently purchased the foundry at Vittoria Street, Soho, formerly in the occupation of Shotton Brothers, Limited, but which has been idle for upwards of nine months; and also the malleable foundry which adjoins, and was formerly worked by Tangyes, Limited, but has not been in operation for some two years. Faced with the necessity of extension, the British Motor Casting Specialities had in the first place decided to erect an entirely new works, and had, in fact, negotiated for a site, as it was recognised that the Vittoria Street Foundry would in itself not afford sufficient space for the varied operations of the company. When, however, it became possible to acquire the foundry from Messrs. Tangyes, the company decided to purchase the whole block of buildings and the adjoining land, and in the first instance to utilise so far as possible the existing plant while carrying out the necessary alterations. A Siemens 2-ton steel furnace will shortly be put into commission, and it is proposed to add an oil-fired converter. Oil-fired crucible furnaces are also installed, though naturally everything is at present in a state of transition, as the company only entered into possession some few weeks ago. One of the new shops will be devoted to briquetting, by pressure, metal swarf. Mr. W. A. Dawkins, managing director of the company, is at present engaged upon experiments in this direction.

Applications for Patents.

The names of communicators are printed in Italic type. A new number will be given when the Complete Specification is accepted.

Avery, W & T., and Cannell, V. L. Tilting furnaces. 1,476. January 30.

Ballentine, W. I. Moulding-machines. 639. January 12.

Boehringer, R. Silicon compounds, and processes of making same 2,005. February 9. (United States, October 26, 1915.)

British Carbonising Company, and Fennell, W. Carburisation and case-hardening of iron and steel articles. 1,388. January 27.

Brown, R. J. W. Case-hardening metals such as steel, iron, iron alloys, etc. 1,753. February 3.

Buckler, C. Compound for hardening or tempering and brazing steel. 1,049. January 22.

Curle, J. A. Burners for liquid fuel. 403. January 9.

Denton, J. J., and Filmer, G. B. Electric furnaces. 1,146. January 23.

Faulkner, V. C. Electric furnaces for melting or refining non-ferrous alloys. 1,674. February 2.

Frantz, A. E. Metal moulds. 1,818. February 5. (France, September 6, 1916.)

Geuze, L. Manufacture of malleable cast iron or steel. 1,717. February 2. (France, February 3, 1916.)

Gill, H. A. (*Nathan*). Flux for brazing cast iron, etc. 447. January 9.

Grist, C. J. Treatment of steel and steel alloys. 1,574. January 31.

Hadfield, Sir R. A. Cast iron, etc. 519. January 10.

Hadfield, Sir R. A. Treatment of iron and steel turnings, scrap, etc. 818. January 16.

Hall, I. Means for casting. 1,795. February 5.

Hurez, E. Regenerative furnaces. 1,344. January 26.

Hydraulic Pressed Steel Company and Marks, E. C. R. Mould forms or frames. 921. January 18.

Ledeboer, P. H. Direct iron-ore process. 858. January 17.

Manchester Furnaces, Limited. Furnaces for heat treatment of metals. 419. January 9.

Marshall, C. Foundry moulding-machines. 703. January 15.

Nathan, J. H. Flux for brazing cast iron, etc. 447. January 9.

Rollason, A. Deoxidization of iron 327. January 8.

Roudy, C. Regenerating-apparatus for furnaces. 1,461. January 29.

Russell, W. A. Furnaces for heat treatment of metals. 419. January 9.

Schaffer, F. Heat treatment of manganese-steel articles. 1,655. February 1.

Schraner, E. Process and oven for cementing and tempering metal objects. 2,067. February 10.

Stackard, S. F. Burners for liquid fuel. 403. January 9.

Tréfileries et Laminoirs du Havre, Anciens Etablissements Lazare Weiller, Soc. Co-operative de Rugles, et la Canalisation Electrique Réunis. Regenerating-apparatus for furnaces. 1,461. January 29.

Personal.

Mr. Stanley Baldwin has been appointed a Junior Lord of the Treasury

The late Mr. B. H. Eberhard, retired iron master, of Solihull, left estate valued at £24,891.

The gross value of the estate of the late Mr. T. H. White, engineer, of Pendleton, is £28,691.

Mr. P. F. Holmes, chairman of W. C. Holmes & Company, Limited, has been made a J.P. for Huddersfield.

Mr. N. A. Lane has been elected a director of Ludlow Brothers (1913), Limited, in place of the late Mr. E. T. Barton.

The gross value of the estate of the late Mr. Herbert Brassey, iron merchant, of the Limes, Curson Park, Chester, is £10,946.

Mr. T. Crosby and Mr. F. Rees have been elected to fill vacancies on the board of directors of the Llanelly Steel Company, Limited.

Mr. Robert Main has been elected chairman of Merry & Cuninghame, Limited, and Col. Pearson has been elected a director of the company.

Mr. J. J. Burton has been elected chairman and Mr. Gerald Cochrane vice-chairman of the Cleveland Ironmasters' Association for the current year.

Mr. J. J. Bryson, general manager of the Penarth Pontoon, Slipway and Ship-repairing Company, Limited, has been elected managing director of the company.

The gross value of the estate of the late Mr. A. Rutherford, principal of the firm of A. Rutherford & Company, Neptune Engineering Works, Birkenhead, is £40,831.

The late Sir George Franklin, a director of the British Thomson-Houston Company, Limited, left estate of the value of £108,167, of which £98,625 is net personalty.

On the occasion of the jubilee of the firm of Steven & Struthers, brassfounders, Kelvinhaugh, Mr. John Steven and Mrs. Steven were made the recipients of handsome presentations by the staff.

In consequence of his appointment as Director-General of National Service, Mr. Neville Chamberlain has resigned his seat on the board of the Birmingham Small Arms and Daimler Companies.

Mr. A. J. While, who for seven years was the general manager of the Barrow Hematite Steel Company, Limited, has been appointed to a responsible position with Alfred Hickman, Limited.

Temp. Second Lieut. D. G. Miller, A. and S.H., who has received the Military Cross, was at the outbreak of war engaged as a member of the staff of Messrs. Denny & Company, Dumbarton.

It is announced that the King has appointed the Marquis of Crewe to be a member of the Committee of the Privy Council for the purpose of the organisation and development of scientific and industrial research.

The council of the University of Liverpool have conferred the title of "Associate Professor" on Mr. J. Wemyss Anderson, lecturer in engineering design and drawing, lecturer in refrigeration, and Dean of the Faculty of Engineering.

Mr. R. E. P. Jameson, a departmental manager of Thos. Summerson & Sons, Limited, railway plant manufacturers, Darlington, who is leaving to take up a position with a Sheffield firm, has been the recipient of a presentation from the officials and men.

Mr. J. Lister, the manager of the Westburn Engineering Works, Arbroath, has received an appointment as general manager in a factory in the West of Scotland, and has been made the recipient of a presentation from the officials and men at the Westburn Works.

Mr. C. J. Hunt, who until recently was chief contract engineer to Bruce, Peebles & Company, Limited, Edinburgh, has been appointed chief engineer to the company, and Mr. Wm. Oliver, who has for some time been acting chief estimating engineer (in the absence of Mr. R. Shaw, on active service) has been appointed chief contract engineer.

Deaths.

Lieutenant J. K. Stead, Yorkshire Regt., younger son of Dr. J. E. Stead, F.R.S., of Middlesbrough, has been killed in France.

Mr. J. Tickell, secretary of the Workington Iron Company, until its absorption by the Workington Iron and Steel Company, died last month.

The death occurred at Birmingham, on February 19, of Mr. J. D. Wragg, head of the firm of Thomas Wragg & Sons, Limited, fire brick makers, Swadlincote.

The death occurred recently of Mr. J. W. Booth, of Riddings, after several months' illness. He was an analytical chemist at the Butterley Company's works.

The death is announced of Mr. G. T. Piggott, a director of Williams Brothers & Piggott, Limited, brassfounders, etc., Small Heath, Birmingham, at the age of 52 years.

Major J. T. Heagerty, Sussex Regt., whose death is announced, was a partner in Messrs. Parker & Heagerty, metal agents, of 6, Lime Street Square, London, E.C. The firm are agents for the Delta Metal Company, Limited.

Mr. W. Lee, senior partner of the firm of Messrs. Lee, Croll & Company, engineers, Lochee, Dundee, died very suddenly last month. The deceased was about 70 years of age, and became a partner of the firm on the death of his brother, between twenty and thirty years ago.

Mr. John Kidner died on February 13, at his residence, "West Hill," Kettering, aged 72. The deceased gentleman was chairman of the Islip Iron Company, Limited, with which company he had been closely connected for upwards of 30 years. He was a Justice of the Peace for the borough.

Mr. Geo. Alder, general manager and secretary of Cochrane & Company, Limited, of Middlesbrough, died suddenly last month. He had been associated all his life with Messrs. Cochrane & Company. He commenced his career as office boy with the company, and ultimately became general manager.

The death has occurred at his residence, 27, Rosslyn Terrace, Sunderland, of Mr. Robson Brown, aged 59 years, managing director of Clarke & Brown, Limited, Pensher. The deceased, who was formerly and for a long time an official at Sir James Laing & Sons' shipyard, was the inventor of many patents.

Mr. James Carter, of Stamford Lodge, Stalybridge, died on February 20 in his 79th year. At one time he was a traveller for the late Mr. Thomas Williamson, brassfounder and finisher, and in 1876 he was taken into partnership. In 1884 he took over the concern, and became the proprietor of the Atlas Works, Stalybridge. He was appointed a borough magistrate in 1896.

Mr. G. A. Hobson, M.Inst.C.E., has died at his residence, Coverdale Lodge, Richmond, Surrey. Born at Leeds in 1854, he became chief assistant to Sir Douglas Fox. In the year 1900 he became a partner in the firm. He was awarded by the Institution of Civil Engineers the Telford Gold Medal and Telford Premium, and the George Stephenson Gold Medal.

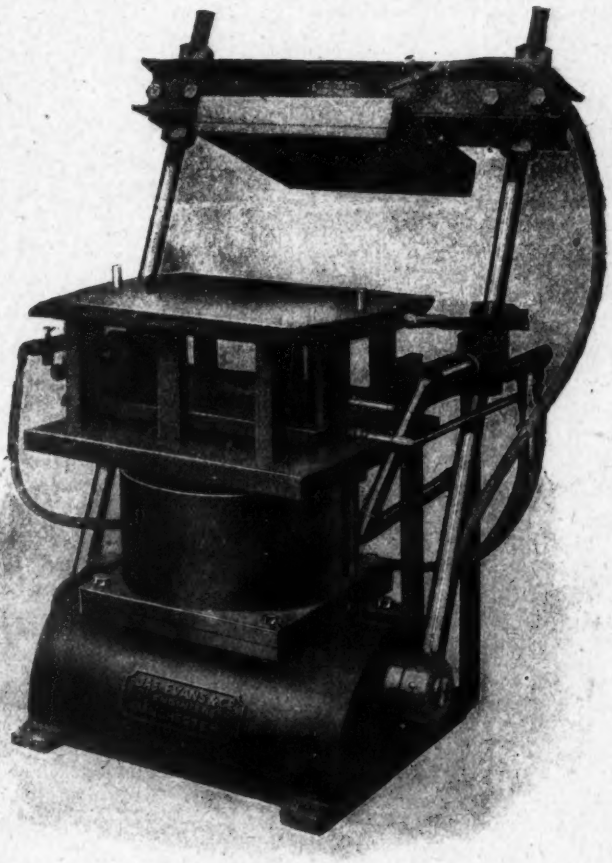
Mr. James Gilchrist, chairman of the firm of Barclay, Curle & Company, Limited, shipbuilders and engineers, Glasgow, died last month at his residence at Kelvinside. Mr. Gilchrist, who was 70 years of age, was associated with the firm of Barclay, Curle & Company for about 55 years, rising step by step from the position of an engineering apprentice to that of chairman

Mr. C. J. Harcourt, J.P., a member of the firm of Harcourts, Limited, brass founders, Moseley Street, Birmingham, died at his residence, at Sutton Coldfield, last month. The son of a brass founder, who carried on business in Lozells, Mr. Harcourt, who was 82 years of age, went to Canada in 1857, but returned on the death of his father, in 1867, to take charge of the business, which was ultimately amalgamated with that of Harcourt, Limited.

MOULDING MACHINES

OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.



JAMES EVANS & CO., BRITANNIA WORKS,

BLACKFRIARS, **MANCHESTER.**

The Control of Lead.

The Ministry of Munitions has issued the appended Order with regard to the control and prices of lead :—

(1) No person shall as from the date hereof until further notice purchase, sell or, except for the purpose of carrying out a contract in writing existing prior to such date for the sale or purchase of lead, enter into any transaction or negotiation in relation to the sale or purchase of lead situated outside the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

(2) No person shall as from the date hereof until further notice purchase or take delivery of any lead situated in the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions, or sell, supply or deliver any such lead to any person other than the holder of such a licence, and in accordance with the terms thereof; provided that no such licence shall be required in the case of any sale, purchase, or delivery of such lead :—

(a) For the purpose of a contract or order for the time being in existence certified to be within Classes "A" or "B" of Circular L.33 as to Control of Output issued by the Minister of Munitions on the 31st day of March, 1916, where the price paid upon such sale does not in the case of virgin pig lead exceed £29 per ton net, and in the case of remelted lead, or old or scrap lead, exceed £26 per ton net.

(b) For the purpose of necessary repairs or renewals involving the use of not exceeding 1 cwt. of such lead.

(3) No person shall as from the date hereof until further notice use any lead for the purpose of any manufacture or work except :—

(a) For the purpose of a contract or order for the time being in existence certified to be within Classes "A" or "B" of Circular L.33 as to Control of Output issued by the Minister of Munitions on the 31st day of March, 1916.

(b) For the purpose of necessary repairs or renewals involving the use of not exceeding 1 cwt. of lead.

(c) For the purpose of type casting from lead already in the form of type or purchased for that purpose at the date hereof.

(d) Under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

(4) All persons shall within ten days from the first day of February, 1917, and within seven days from the first day of each succeeding month, send in to the Director of Materials (A.M.2.(E)), Hotel Victoria, Northumberland Avenue, London, S.W., monthly returns of :—

(a) All lead held by them in stock or otherwise under their control on the last day of the preceding month.

(b) All lead purchased or sold by them for future delivery and not yet delivered on such last day, together with the names of the sellers to or purchasers from them.

(c) All lead delivered to them during the preceding month.

(d) All contracts or orders existing on the last day of or entered into during the preceding month requiring for their execution the use of lead for any purpose, specifying the amounts of lead required weekly for the purposes of such contracts or orders and distinguishing between the amounts required for Classes "A" and "B" respectively of Circular L.33, and the amounts required for other purposes.

Notwithstanding the above no return is required from any person whose total stock of lead in hand and on order for future delivery to him has not at any time during the preceding month exceeded 1 cwt.

(5) For the purpose of this order the expression lead shall mean pig lead, whether virgin or remelted, sheet lead, lead pipe, and old and scrap lead or any of them.

(6) All applications for licences to purchase or use lead shall be made to :—

The Director of Materials (A.M.2.(E)),
Hotel Victoria,
Northumberland Avenue,
London, S.W.,

and marked "Lead Licence."

NOTE.—Licences to purchase and take delivery of lead situated in the United Kingdom will usually be granted by the Minister of Munitions under the above order for necessary repairs and renewals in the ordinary course of trade, and will also be granted for any other purposes which may be approved by the Minister of Munitions, including manufacture for the purposes of export trade.

Every applicant for a licence must state the amount of metal required by him per month and the use to which it will be put.

Any person acting in contravention of or failing to comply with the above order will be guilty of an offence under the Defence of the Realm Regulations and be liable to penalties of fine and imprisonment.

Aluminium Stocks.

Under date of February 18, the Minister of Munitions has issued an order authorising all persons, in the first seven days of each month commencing with March, 1917, to send in to the Director of Materials A.M.2 (H), Hotel Victoria, Northumberland Avenue, London, S.W., monthly returns of :—

(*a*) All aluminium held by them in stock or otherwise under their control on the last day of the preceding month.

(*b*) All aluminium purchased or sold by them for future delivery and not yet delivered on such last day, together with the names of the sellers to or purchasers from them.

(*c*) All aluminium delivered to them during the preceding month.

(*d*) All aluminium scrap or swarf produced by them and/or issued from their works during the preceding month.

(*e*) All contracts or orders existing on the last day of or entered into during the preceding month requiring for their execution the use of aluminium specifying the purposes thereof.

Notwithstanding the above, no return is required from any person whose total stock of aluminium in hand and on order for future delivery to him has not at any time during the preceding month exceeded 56 lbs.

For the purpose of this order the expression aluminium means :—

Aluminium and alloys of aluminium, unwrought and partly-wrought, including ingots, notched bars, slabs, billets, bars, rods, tubes, wire, strand, cable, plates, sheets, circles and strip.

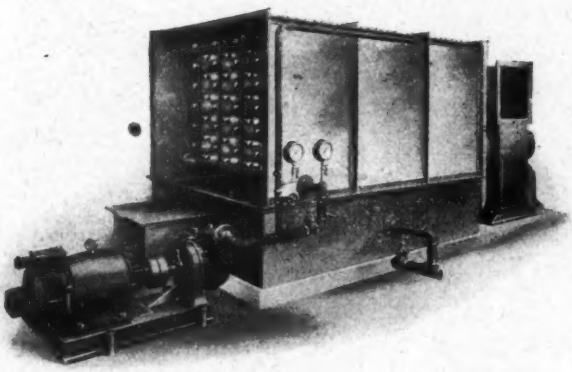
Aluminium scrap and swarf, aluminium alloy scrap and swarf, remelted aluminium scrap and remelted aluminium alloy scrap and swarf.

Granulated aluminium, aluminium powder, "bronze," "flake," and "flitter," or any of the above.

Any person failing to comply with the above order or making a false declaration will be guilty of an offence against the Defence of the Realm Regulations and be liable to penalties of fine and imprisonment. Attention is drawn to the fact that under the order made by the Minister of Munitions on December 2, 1916, whereby Regulation 30 (A) of the Defence of the Realm Regulations was applied to aluminium as above defined, all dealing or negotiations for dealing in aluminium without a permit as specified in that regulation is illegal and an offence against the Defence of the Realm Regulations.

TRADE SIROCCO MARK

Air Washers

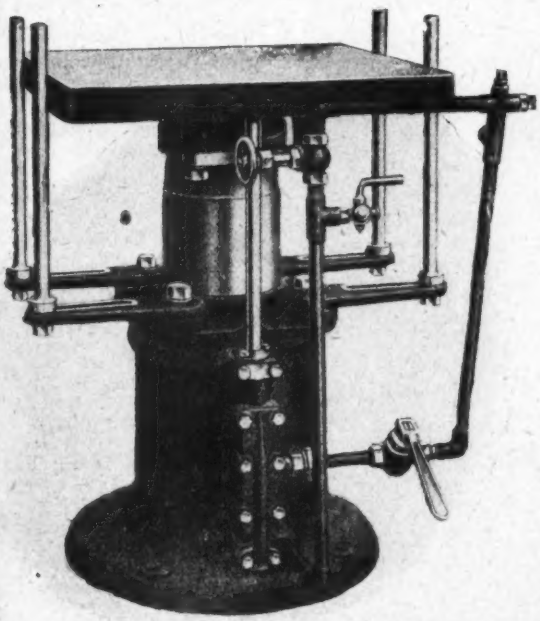


CLEAN AIR
For
Air Compressors

These Washers ensure clean valves and cylinders and the elimination of grit troubles and their attendant expenses.

See Publication No. 1013 K.

DAVIDSON & CO., LD.
Sirocco Works,
:: BELFAST. ::



"BRITANNIA"
JAR RAM MOULDING MACHINE

(Daimler and Wardles Patent),
fitted with

SELF-CONTAINED LIFTING APPARATUS

Makers:
BRITANNIA FOUNDRY CO.,
Coventry.

London Agents: MURPHY, STEDMAN & CO., 180, GRAY'S INN ROAD, W.C.

New Companies.

Deptford Steel & Ironworks, Limited. — Capital £20,000 in £1 shares (10,000 preferred ordinary).

Gas Development, Limited.—Capital £20,000 in £1 shares, to carry on the business of engineers, etc.

Thermalloy, Limited.—Capital £10,000 in £1 shares, to carry on the business of munition manufacturers.

Eveleigh Bishop, Limited.—Capital £20,000 in £1 shares to carry on the business of hardware manufacturers.

Helena Engineering Company, Limited. — Capital £5,000 in £1 shares (1,000 10 per cent. cumulative preference).

Thames Slipway Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office:—52, Mark Lane, London, E.C.

Chatteris Engineering Company, Limited.— Capital £50,000 in £1 shares (25,000 preference). Registered office:—139-40, Gresham House, Old Broad-street, E.C.

Chas. W. Cook, Limited. — Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office: Universal Works, Bridge Street, Manchester.

Brownlie & Green, Limited.—Capital £30,000 in £1 shares (10,000 preference), to carry on the business of engineers, electricians, etc. Registered office: 2, Austinfriars, E.C.

Leeds Tool & Manufacturing Company, Limited. — Capital £20,000 in £1 shares, to take over the business of a firm of similar name. Registered office:—121, Elland-road, Leeds.

Lehmann, Archer, & Company, Limited. — Capital £29,000 in £1 shares, to carry on the business of engineer's tool manufacturers. Registered office:—5, Farringdon Road, E.C.

G. E. Ambaticlos & Company, Limited. — Capital £2,000 in £1 shares, to carry on the business of steamship builders, repairers, etc. Registered office: 46, St. Mary Axe, London, E.C.

R. Becker & Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of manufacturers of and dealers in machinery, etc. O. G. R. Becker is the first director. Registered office: 53, City Road, E.C.

Curran Brothers, Limited.—Capital £10,000 in £1 shares, to take over the business of furnace and oven builders, engineers, etc., carried on at Cardiff by E. Curran and F. H. Turnbull as Curran Brothers. The first directors are E. Curran and F. H. Turnbull.

Sheffield Scissors, Razor and Tool Company, Limited.—Capital £10,000 in £1 shares (9,000 preference), to take over the business carried on at Chaucer Works, Clough Road, etc., Sheffield, as the Sheffield Scissors, Razor & Tool Company. The director is A. H. Wild.

James Fairley & Sons, Limited.—Capital £60,000 in £1 shares, to take over the business carried on at Birmingham and Sheffield as James Fairley & Sons, and to carry on the business of ironmasters, etc. Registered office:—9-10, Shadwell Street, Birmingham.

Guiseley Silica Company, Limited.—Capital £6,000 in £1 shares, to take over the business of silica and ganister producers and grinders, etc., carried on by Messrs. F. Whitaker and C. F. Whitaker. The first directors are F. Russell, F. Whitaker and C. F. Whitaker.

East Coast Steel Corporation, Limited.—Capital £100,000 in £1 shares, to carry on the business of iron and steel masters and manufacturers, steel converters, etc. The first directors are the Rt. Hon. Baron Furness, of Grantley, and B. Talbot. Secretary, A. Sladden. Registered office:—Moor Works, Stockton-on-Tees.

Ransome & Marles Bearing Company, Limited.—Capital £60,000 in £1 shares, to take over the ball and roller bearing branch of the business of A. Ransome & Company, Limited, and to carry on the business of engineers, etc. The first directors are V. S. Woods, L. H. Ransome and J. C. Clark. Registered office: Stanley Works, Newark-on-Trent.

Queenstown Dry Docks, Shipbuilding and Engineering Company, Limited.—Capital £100,000 in £1 shares to take over the premises occupied by the Queenstown Dry Docks, Shipbuilding and Engineering Company, comprising the Royal Victoria Docks, the Albert Triple Dock, granaries, buildings and erections for carrying on repairing, docking, shipbuilding and general engineering, etc., at Passage West. The first directors are:—Walter Furness and Ethelbert Furness. Registered office:—Royal Liverpool Building, Liverpool.

George H. Cook & Company, Limited.—Capital £5,000 in £1 shares, to take over the business of a steel manufacturer and merchant now carried on by G. H. Cook at Styrian Steel Works, Renton Street, Sheffield, as George H. Cook & Company (recently purchased by G. H. Cook from G. C. Webster, C.A., controller and liquidator of the business of Bohler Brothers & Company, under the Trading with the Enemy Act). The first directors are G. H. Cook, H. Sagar, and C. J. Glanville (all permanent).

Associated British Machine Tool Makers, Limited.—Capital £100,000 in £1 shares, to carry on the business of machine and engineering tool manufacturers, mechanical and electrical and general engineers, etc. The signatories are: W. B. Lang, The Grange, Johnstone, near Glasgow, engineer; G. W. Gregory, 9, Biron Lane, Manchester, engineer; S. A. Smith, New Holme, Harborough Road, Ashton-on-Mersey, manufacturer; G. Thompson, Shepperton, Selly Wick Road, Birmingham, manufacturer; W. F. Clark, Bartley Cottage, Northfield, Birmingham, engineer; W. G. Shanks, Melfort House, Milliken Park, near Glasgow, engineer; S. H. March, Redclyffe, Chorlton-cum-Hardy, engineer; H. Butler, Fern Bank, Halifax, engineer. The first directors are: W. F. Clark, J. W. S. Asquith, S. H. March, A. H. Baldwin, W. B. Lang, A. E. Matthewson, W. G. Shanks, W. D. Ford-Smith, E. Williams, and H. Butler. Registered offices: 34, Victoria Street, London, S.W.

The Manchester and District Decimal Association has been formed to endeavour to secure a change in our coinage and weights and measures. The president is Mr. Thos. Smethurst, Lord Mayor of Manchester, and the vice-presidents include Sir Wm. Mather, Mr. James McKechnie, Mr. C. T. Needham, M.P., and Sir John S. Randles, M.P. On the council we note Mr. Harry Allcock, Mr. A. Wallace Cowan, Mr. B. Longbottom, Mr. Hans Renold, Mr. R. H. Schofield, Mr. F. J. West, and Mr. A. P. Wood. As one important step in the direction of increasing the export trade, the Association are advocating that our present unwieldy systems of coinage, weights and measures should be abandoned in favour of a complete decimal system, such as foreigners would readily understand. Our present system could be rearranged on a decimal basis without altering the existing values of our gold and principal silver coins. For instance, we could adopt our present florin as the standard coin and divide it into 100 cents (instead of 96 farthings). Alternative proposals, by which the present penny would be retained as the standard coin involving the introduction of new coins representing decimal multiples of the penny, have been advocated from time to time, but hitherto with little success, probably because under any such scheme the £ sterling could not survive. Under the Association's proposals the £ sterling is retained. At present British manufacturers and merchants are compelled to work in the Imperial system of weights and measures for their home trade, and in the metric system for their trade with "Metric" markets abroad. The extra work and liability to error attendant on the necessary conversion of a metric inquiry into Imperial terms, and its subsequent reconversion into the metric system, obviously hamper the British exporter in his efforts to develop his foreign trade. In practice it would be found during the period of transition that whereas new standards would naturally be based on the metric system, all existing standards could remain in use for manufacturing purposes until, in the normal course of development, they became obsolete.

Telegrams: "Durrans, Penistone." Telephone: 21, Penistone

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

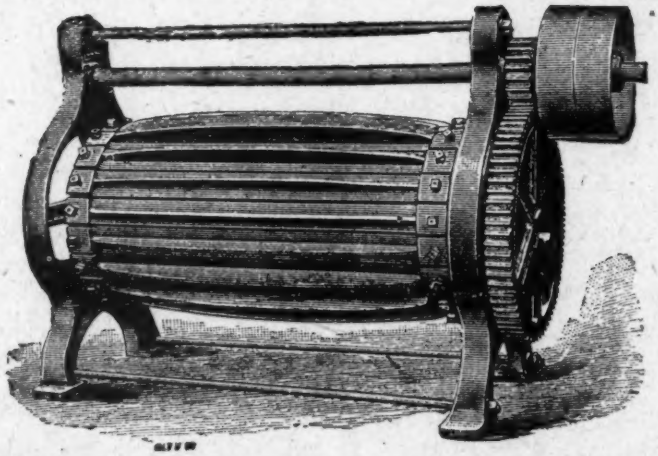
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

These maximum prices of iron, steel and coke were fixed by the Government until June 30, 1916, and thereafter until further notice. Makers may sell for delivery after June 30, on the understanding that the fixed maximum prices ruling on the 1st day of any month during the period of the contract will apply to all deliveries made during that month. This intimation must not be taken to authorise any sale or purchase or other dealing prohibited under the Defence of the Realm Regulations

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos., 1, 2 and 3	6	7	6
Special under 0.03 P. & S... ..	6	15	6
" " 0.02 "	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.04 P. & S. ..	6	7	6
Special under 0.03 P & S. ..	6	15	6
" " 0.02 "	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3..	6	2	6
Special under 0.03 P. & S. ..	7	10	0
Welsh hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S. ..	6	15	6
" " 0.02 "	7	0	0
Lincolnshire, basic or foundry ..	4	12	6
Cleveland, No. 1	4	11	6
" other grades	4	7	6
Northamptonshire, forge	4	7	6
" fdy. numbers	89/0		94/0
Derbyshire, forge	4	10	0
" foundry numbers	92/6		96/6
Derby & Notts. basic.	4	17	6
Leicestershire & Notts., forge ..	4	10	0
" " foundry nos.	92/6		96/6
North Staffs, forge	4	15	0
" " foundry	4	17	6
" " basic	4	17	6
South Staffordshire—			
Part mine forge	4	15	0
" foundry	4	17	6
Common Staffordshire ..	4	10	0
All mine forge	5	15	0
" foundry	6	0	0
Warm air forge	7	5	0
" foundry	7	15	0
Lord Dudley's silicon	8	7	6
Cold blast	9	2	6
Scotch foundry and forge—			
Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan.. ..	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1¼%

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows :—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 3s. 10d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows :—

Millings and Turnings	5d
Bar Ends	6d

Both per lb. net delivered steel makers works.

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome : 4/6% carbon. Basis 60%, scale 10s. per unit Per ton		—	
Ferro-chrome : 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton		—	
Ferro-chrome : 8/10% carbon. Basis 60% scale, 10s. per unit Per ton		—	
Ferro-chrome : Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton		—	
Ferro-vanadium : 33/40% Va., per lb. of Va. contained in the alloy		—	
Ferro-silicon : 45/50%. Basis 50%, 5s. scale per unit .. Per ton		—	
Ferro-titanium : 23/25%, per lb. carbonless..		—	
Ferro-molybdenum : 70/80% Mo. per pound of Mo. contained ..		—	
Ferro-phosphorus : 20/25%. Per ton		—	
Ferro-tungsten : 75% to 80% per lb. of metallic tungsten contained		—	
*Ferro-manganese 80%		—	
" export		—	

* F.o.b. Liverpool.

Non-Ferrous Metals.

Copper.

	£	s.	d.	£	s.	d.
Standard, Cash	139	0	0	140	0	0
Three months	136	10	0	137	0	0
Electrolytic ..	151	0	0	147	0	0
Tough	—			—		
Best selected	—			—		

Tin.

Standard, Cash	200	15	0	201	0	0
" Three months	200	15	0	201	0	0
English Ingots ..	—			205	10	0
Bars	—			—		
Refined	—			—		

Spelter.

American	—			56	15	0
Specials..	—			—		
Hard	—			—		
British	—			—		

Lead.

Soft Foreign	30	10	0	29	10	0
English	—			Nom.		

Antimony.

Regulus	—			85	0	0

Aluminium.

Virgin Metal 98/99% per ton	—

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots.. ..	—

CASTINGS.	Per lb.
I. or II.	—
III. IV. or V.	—
VI. or VII	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. price of best selected copper.	35/- above
15 per cent. Phosphor Copper .. price B.S.	40/- above
Phosphor Tin (5 per cent.) .. price of English Ingots.	£23 above

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM)

***Chromium (Metallic).**

98/99% purity, per lb.	—

***Nickel.**

In cubes, 98/99% purity Per ton	—

Nickel Silver.

	per lb.
Ingots for raising	—
Ingots for Spoons and Forks ..	—
" rolled to spoon size ..	—

***Tungsten Metal Powder.**

96/98% purity.. per lb. ..	—

***Molybdenum Metal.**

96/98% purity.. per lb. ..	—

***Cobalt Metal.**

97% purity .. per lb. ..	—

Quicksilver.

75 lb. bottle	—

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.	s.	d.
Steel scrap, heavy melting..	105	0	—	
Iron scrap cast (cupola metal)	90	0	95	0

London (f.o.b.).

Heavy steel			100	0
Light "			55	0
Heavy cast			85	0

Control Prices.

Heavy Steel Melting Scrap	105	0	125	0
Turnings and Borings			50	0

Per ton delivered Buyers' Works.

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations :—

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap ..	—		
Hy. Selected Scrap Brass ..	88	0	0
Hy. Tinned Copper Wire	—		
Best Selected Gunmetal Scrap ..	120	0	0
Re-melted Ingot Lead	—		

Stocks.

Metals.

	Tons.
Copper, Europe and afloat	—
Tin, London, Holland, U.S.A. and afloat	—

Coke.

Middlesbrough.

	s.	d.	s.	d.
Gas Coke	31	0	—	

Glasgow.

Foundry Coke	—		42	6
Furnace Coke	31	0	—	
Gas Coke	—			

London.

Welsh or Durham Foundry, d/d London Stations in truck	45	6	53	0
Ditto, d/d Birmingham Stations	44	0	48	0
Yorkshire, d/d London Stations, in truck	42	6	—	
Ditto, d/d Birmingham Stations	39	6	—	

CONTROL PRICES OF COKE.

	s	d.
Durham and Northumberland blast furnace	28	0
" foundry	30	0
South Yorkshire, West Yorkshire, Lancashire, Staffordshire and Midland Counties blast furnace	25	3
South Wales blast furnace ..	30	0
" foundry	43	0

All per ton net. f.o.t. ovens.

SITUATIONS VACANT AND WANTED.

WANTED energetic WORKS MANAGER for Steel Foundry, South of England. No one eligible for military service will be engaged.—Write, with full particulars of experience, copies of testimonials, and salary required, to Box 862, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C.

FOUNDAY FOREMAN desires Situation; experienced in loam, dry, and green sand; machine moulding and repetition work.—Box 868, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C.

STEEL Foundry Foreman desires SITUATION; experienced in loam, dry, and green sand; good organiser, and well up in modern foundry practice.—Address, Box 870, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C.

WANTED, a FOUNDRY WORKS' MANAGER, with full knowledge of machine moulding and capable of installing a machine-moulding plant; must be a thoroughly competent man, and used to this class of work.—Apply, Box 872, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C.

ADVERTISER wishes to hear from Firm requiring Foundry or Works Manager (ineligible) of very wide and varied experience. General engineers, etc. (light and heavy); modern methods; repetition work; sound organiser.—Full particulars, in confidence, to L2, FOUNDRY TRADE JOURNAL, 165, Strand, London W.C.

FOUNDRY MANAGER, age 44, at present holding responsible position in the Colonies, is willing to return to England to take up a similar position, or to assist in munition work. Used to the production of heavy castings, to varied specifications, and to shops employing 80 to 100 moulders, etc. Expert in moulding machine work, and in reclaiming sands, etc.— Address Box 876, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FIREMAN required for Aluminium and Gunmetal Foundry. S.W. London. Good wages and prospects for first-class man, used to Admiralty mixings preferred. Those not on Government work or having employer's consent should apply through nearest Labour Exchange mentioning *Foundry Trade Journal*, and No. 878.

FOR SALE AND WANTED.

FANS and BLOWERS.—Engine-driven, Roots' Blower, No. 5, 13½ in. discharge; Engine-driven Fan, 34 in. by 14½ in. discharge; Belt-driven Fan, 18 in. discharge; splendid ditto, 9 in. discharge; Belt-driven Roots' Blower, 5 in. discharge.—Whyte, John Street, Greenock.

WANTED, good Machine for Twisting and Coiling Straw Rope.—Apply Box 874, FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE.—24-in. Invincible Sand Mixer, capacity 3 tons per hour, for grinding, mixing and screening foundry sands, at lowest cost per ton.—Apply HALL 26, Paradise Square, Sheffield.

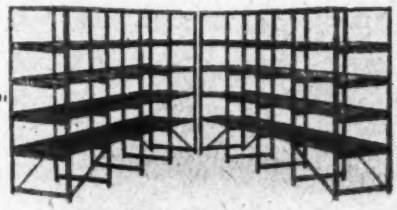
FOR SALE AND WANTED.—*cont.*

12 IN. Roots' Blower, by Dempster, driven direct by horizontal steam engine; 8-in. ditto, by Thwaites, with vertical engine, self-contained; low price; immediate delivery.—WILLIAMS & SONS, South Bermondsey Railway Station, London, S.E.

BLOWING FAN, by Alldays, 12 in. outlet; EXHAUST FAN, cast-iron casing, 10 in. outlet and inlet, F. and L. pulleys; BAKER'S BLOWER, 6 in. outlet; 30 in. New Belt-driven VENTILATING FAN; cheap.—Parker, Siddals, Derby.

F. L. HUNT & CO..
FOUNDRY
FURNISHERS
AND
FOUNDRY REQUISITES
Of every description.
56, 58, 60, CHAPEL STREET, SALFORD, MANCHESTER.

T. E. MANSERGH.
EVERY DESCRIPTION OF
MOULDERS'
PATENT WOOD, MINERAL AND
COAL DUST BLACKINGS
MANUFACTURED.
Wheathill Charcoal Works, SALFORD.



SANKEY
Fireproof Steel Storage Bins
For Workshop and Warehouse
Write for Details.
Joseph Sankey & Sons, Ltd.,
Hadley Castle Works, WELLINGTON, Shropshire.

PLUMBAGO—CRUCIBLES.

Parting Powder.

William OLSEN,
Cogan Street, HULL.

FOUNDRY MATERIALS AND REQUISITES.

Largest Stock of Straw and Wood Fibre CORE ROPINGS.

Wax Core Vent.

GLUTRIN—CORE GUM.

FIRE BRICKS & CLAY
CUPOLA BRICKS.
Best Quality.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,
(STOURBRIDGE) Ltd.,
STOURBRIDGE.

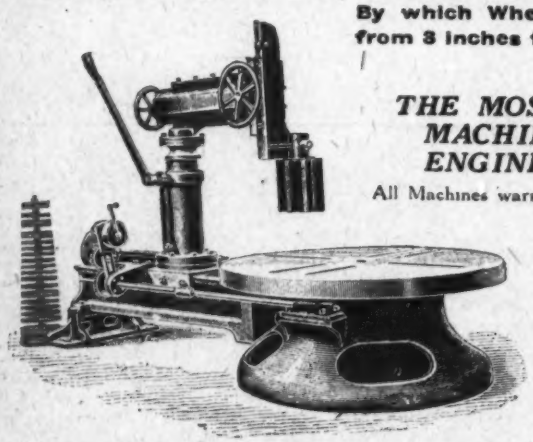
38"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL, LTD.
KINNING PARK IRONWORKS,
GLASGOW
36"
32½"

CAN ALSO BE MADE IN ALUMINIUM.

Kindly mention this paper when enquiring or ordering.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.



THE MOST COMPLETE AND EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

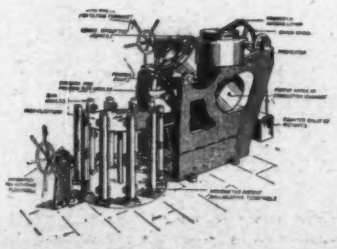
WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***

Index to Advertisers.

Addresses, Telegraphic Addresses, and Telephone Numbers.

PAGE.	NAME.	ADDRESS.	TELEGRAPHIC ADDRESS.	TELEPHONE NO.
170	Alldays & Onions, Ltd.	Birmingham	Alldays, Birmingham	28 Victoria
179	Anglo-Mexican Petroleum Co., Ltd.	Finsbury Court, Finsbury Pavement, E.C.	Mexproduct, Ave, London	City 2704
172	Baldwin (Aston) Ltd., J. & W.	Aston, Birmingham	"Splinters" Birmingham	254-5 East
179	Braby, F. & Co., Ltd.	Petershill Road, Glasgow	Braby, Glasgow	—
C. iii.	Bradley, T. & I. & Sons, Ltd.	Darlaston	Bradley, Darlaston	—
219	Britannia Foundry Co.	Coventry	Stoves, Coventry	251
174	British Binderit Co., Ltd.	Wharf Road, Wandsworth, S.W.	Bindercomp, Wands., London	994 Putney
C. ii.	British Thermit Co., Ltd.	49 & 51 The Albany, Liverpool.	Thermetal, Liverpool	1680 Central
181	Broadbent, T. & Sons	Huddersfield	Broadbent	1581 (4 lines)
C.iv.	Buckley & Taylor, Ltd.	Castle Iron Works, Oldham	Engines, Oldham	Oldham No. 8
	Cox & Son	King's Road, Hay Mills, Birmingham	Heatrap, Birmingham	4 Victoria.
180	Cumming, William & Co., Ltd.	Maryhill, Glasgow	Prndeuce, Glasgow	P.O.M. 25
219	Davidson & Co., Ltd.	Belfast	Sirocco, Belfast	4341 Belfast
	Davies, T. & Son	West Gorton, Manchester	Tuyere, Manchester	70 Openshaw
221	Durrans, Jas. & Sons	Penistone, nr. Sheffield	Durrans, Penistone	21 Penistone
182 & 217	Evans, J. & Co.	Manchester	Ladles, Manchester	2297
178	Everitt & Co.	40, Chapel Street, Liverpool	Persistent, Liverpool	1134 Central (3 lines)
178	Fyfe, J. R., & Co.	Shipley, Yorks	Brick, Shipley	59 Shipley
172	Gibbons, James	Wolverhampton	—	—
	Glasgow Patent Moulders Blacking Co.	26, Fleming St., Port Dundas, Glasgow	Moulders, Glasgow	—
	Goldendale Iron Co., Ltd.	Tunstall, Stoke-on-Trent	Goldendale, Tunstall, Staffs	—
178	Hall, John & Co. (Stourbridge), Ltd.	Fire Clay Works, Stourbridge	Hall, Stourbridge	55 Stourbridge
177	Hedley Moorwood & Co., Ltd.	21, Church Street, Sheffield	Morod, Sheffield	4318
	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
223	Hunt F. L. & Co.	56, 58, 60 Chapel St, Salford, Manchester	—	—
224	King Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
	Lawson Walton & Co.	2, St. Nicholas Bldgs, Newcastle-on-Tyne	—	—
178	Lowood, J. Grayson, & Co., Ltd.	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
C. i.	Macdonald, John, Ltd.	Watt Street, Maryhill, Glasgow.	"Compressor, Glasgow."	61 Maryhill (N)
173	Mansergh, T. E.	Wheathill Charcoal Works, Salford	—	—
	Marshall, H. P. & Co.	Leeds	Speciality, Leeds	1909 Leeds
	Metalline Cement Co.	112, Bath Street, Glasgow	Adhesive, Glasgow	201Y2 Douglas
224	McNeil, Chas., Ltd.	Kinning Park, Glasgow	McNeil, Glasgow	X 155
169	Monometer Manufacturing Co., Ltd.,	Whitehouse St., Aston, Birmingham	—	—
173	Naish & Croft	150, Alma Street, Birmingham	—	—
224	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	Nat. 1184
C. iii.	Phillips, J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central
181	Portway, Chas. & Son	Halstead, Essex	Portway, Halstead	10 Halstead
175	Samuelson & Co., Ltd.	Banbury	Samuelson, Banbury	17 Banbury
223	Sankey, Joseph & Sons, Ltd.	Hadley, Salop	Sankey, Hadley	—
173	Stewart, D. & Co., Ltd.	London Road Iron Works, Glasgow	Stewart, Glasgow	71 P.O. Bridgton & 3243 Bridgton (N.)
178	Spermolin Core Co.	Spermolin, Halifax	Halifax	397
C. ii	Thermit Ltd.	675, Commercial Road. E.	Fulmen, Step, London	East 4157
	Tilghman's Patent Sand Blast Co., Ltd.	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
176	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	3456 & 3460 Brdf'd.
180	Universal Machinery Corporation, Ltd.	326, Old Street, London, E.C.	Toolcraft, London	3763 London Wall.
172	Universal System of Machine Moulding and Machinery Co., Ltd.	97, Queen Victoria Street, London. E.C.	Machimould, London,	2243 City
173	Walker, I. & I.	Rotherham	—	—
	Walco, Ltd.	53, Newton Street, Birmingham	Walco, Birmingham	Central 3305
224	Whittaker, W. & Sons, Ltd.	Oldham	Whittakers Engineers, Oldham	83
181	Wilkinson, Thos. & Co., Ltd.	Middlesbrough	Blacking, Middlesbro'	419
	Williams, J. (Birmingham Sand), Ltd.	Birmingham	—	—



Monometer Patent Tilting Furnace and Mould-Carrying Turntable.

50% to 65%
Saving in Crucibles

Monometer Oil-fired 800 lb. Tilting Furnace *(manufactured under Hall's Patent)* **has actually reduced the cost in crucibles in Pot-hole furnaces from 6d. to 2½d. per cwt. of Brass melted.**

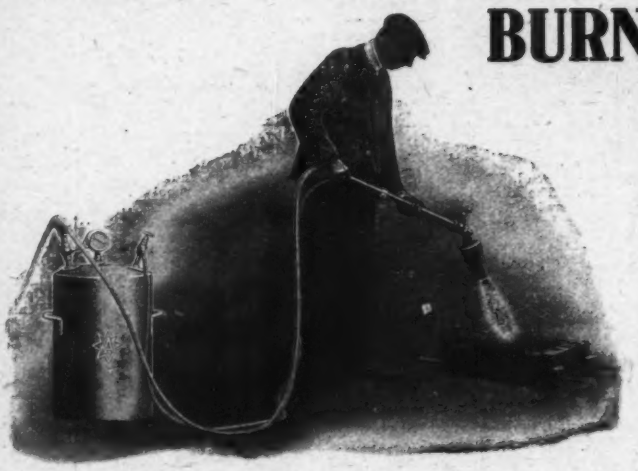
Monometer Mfg. Co., Ltd.

Engineers and Ironfounders,

ASTON, BIRMINGHAM.

Edited by I. H. Hall, Managing Director.

ALLDAYS "EMPIRE" PORTABLE BURNER OUTFIT



Pattern No. 07 for Crude or Creosote Oil.
FOR COMPRESSED AIR.

FOR OIL FUEL

is extremely useful for Mould Drying, Cupola Lighting, and for a variety of heating purposes in the Foundry, and a very intense heat can be obtained in a few minutes if so desired.

We are Makers of :—

MELTING FURNACES

——OIL, GAS, COAL OR COKE FIRED.——

CRUCIBLE TILTING TYPE,
CRUCIBLE STATIONARY TYPE,
OPEN HEARTH TYPE,
LIFT OUT TYPE,
ROLLING FURNACES, etc.
"CLIMAX" ROOTS BLOWERS,
"EMPIRE" POSITIVE PRESSURE BLOWERS,
"DUPLEX" BLOWING FANS, etc.

Pattern No. O 8
FOR USE WITH PARAFFIN.

ALLDAYS & ONIONS PNEUMATIC ENGINEERING Co., Ltd.,

DEPARTMENT "B" BIRMINGHAM,

—— AND AT ——

58, HOLBORN VIADUCT, LONDON, E.C.

FOUNDRY CUPOLAS, LADLES,

And the

OSBORN'S PATENT CUPOLA

SPARK ARRESTER

Are the Specialities of

T. DAVIES & SON,

RAILWAY WORKS, WEST GORTON, MANCHESTER.

ON ADMIRALTY LIST.

Telegrams—"TUYERE, MANCHESTER." Nat. Telephone—No. 70, OPENSHAW.

London Agents: MURPHY, STEDMAN & CO., Ltd., 180, Gray's Inn Road, London, W.C.

FOUNDRY MOULDING MACHINES

For INTRICATE and SIMPLE CASTINGS

For Great Britain: **Send Blue Prints or Sample Castings.**

The UNIVERSAL SYSTEM of MACHINE MOULDING

and MACHINERY COMPANY, LIMITED,

97, QUEEN VICTORIA STREET, LONDON, E.C.

Tele. Ad.: Machimould, London. (Over 5,000 Machines now running.) Telephone: City 2243.

For Allied and Neutral Countries:

Établissements PH. BONVILLAIN & E. RONCERAY, PARIS.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

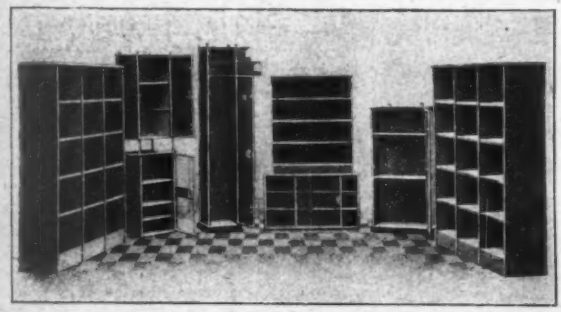
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."



GIBBONS

Wrot Iron Divisions and Gates

FOR

WORKSHOPS, CLOAK ROOMS, STORES, WAREHOUSES, Etc.

JAMES GIBBONS,

St. John's Works, WOLVERHAMPTON.

London Office: Fisher St., Southampton Row.

WOOD WOOL ROPE

FOR CORE MAKING. *ALL SIZES from ¼ to 1½ in. DIAMETER.*

Contractors to H.M. Government

J. & W. BALDWIN (Aston), Ltd.

TELEGRAMS: "Splinters," Birmingham. PHONE: East, 254 and 255.

Actual SALFORD STREET, ASTON, BIRMINGHAM. Manufacturers.

WOOD WOOL

FOR PACKING AND FILTERING PURPOSES.

ANALYSES

MECHANICAL TESTS
and MICROGRAPHS

Consulting Metallurgists and Analytical Chemists.

— SPECIALISTS —
IN FOUNDRY WORK.

Laboratory for all kinds of Metallurgical Investigations.

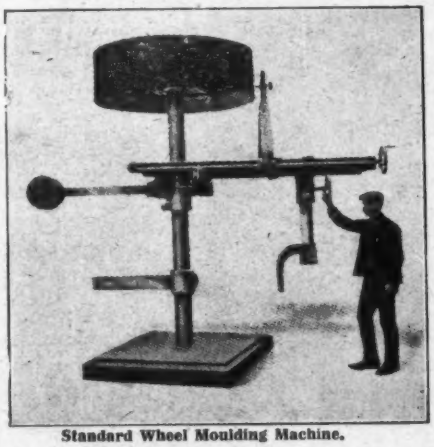
NAISH & CROFT,

150, Alma Street, BIRMINGHAM. | 24, University Mansions, Putney, LONDON, S.W.

T. E. MANSERGH.

EVERY DESCRIPTION OF
MOULDERS'
PATENT WOOD, MINERAL AND
COAL DUST BLACKINGS
MANUFACTURED.

Wheathill Charcoal Works, **SALFORD.**



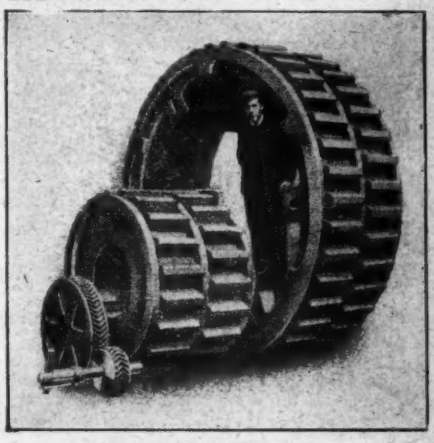
Standard Wheel Moulding Machine.

ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

Complete Satisfaction Guaranteed



Wheels Moulded by this Machine.

No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

WRITE FOR PRICE AND PARTICULARS TO

DUNCAN STEWART & CO., LTD.,

LONDON ROAD IRONWORKS, GLASGOW.

WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

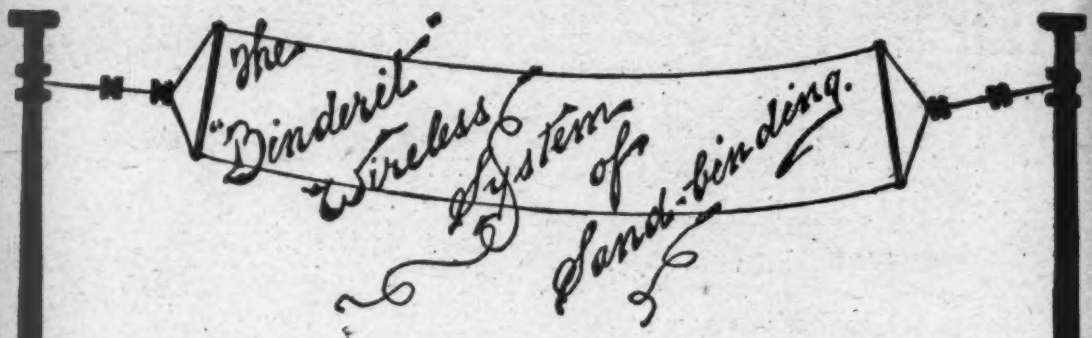
FOUNDRY BLACKINGS

OF ALL KINDS

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, EFFINGHAM MILLS, ROTHERHAM.

Our Specialite is Studying Special Requirements.
KINDLY HAND US YOUR ENQUIRIES.



"BINDERIT"

ALL BRITISH MADE

FOR USE IN THE FOUNDRY.

THE BRITISH BINDERIT Co., Ltd.,

is entirely **BRITISH.**

THE BRITISH BINDERIT CO. SPECIALISE IN THOSE REQUISITES WHICH ARE ABSOLUTELY NECESSARY FOR SUCCESSFUL CASTINGS PRODUCTION

"BINDERIT" is the sand binder of proved reliability and is the most economical and efficient sand binder extant.

"BINDERIT" supersedes all oil, oil compounds, gums or starches, and excels all other water soluble binders for cohesion and porosity.

"BINDERIT" is supplied in lump or liquid form, also as a powered core compound.

"BINDERIT" readily dissolves in cold water.

"BINDERIT" can be used with every kind or variety of sand and is used for sand mixes for steel, iron or non-ferrous castings.

"BINDERIT" reduces fettling charges to the minimum and practically eliminates the uses of wires or irons.

"BINDERIT" Silica or black-washes are of unrivalled excellence and superior to all others.

FOR FULL PARTICULARS AND PRICES APPLY TO—

THE BRITISH BINDERIT Co., Ltd.,
BINDERIT WORKS,
WHARF ROAD.
WANDSWORTH, S.W.

Binderit
Trade Mark.

Telegrams:
"BINDERCOMP, WANDS., LONDON."

Telephone: 994 PUTNEY.

IMPORTANT TO IRONFOUNDERS.

MOULDING—MACHINES

FOR REPETITION FOUNDRY WORK.

Illustration of

HAND PRESS MACHINE

for Small Repetition Work, giving rapid and Economical Production.

Makers also of a

HAND RAMMING MACHINE

where a Deep Lift is required. Can be Operated by

UNSKILLED LABOUR.

MOST EFFICIENT AND ECONOMICAL IN USE.

Also Makers - - of - - **ROOTS' "ACME" BLOWERS.**

FULL PARTICULARS FROM—

SAMUELSON & Co., Ltd., BANBURY, ENGLAND.

SEE OUR ADVERTISEMENT EVERY ALTERNATE MONTH.

FOUNDRY PLANT.

"Rapid" Cupolas,

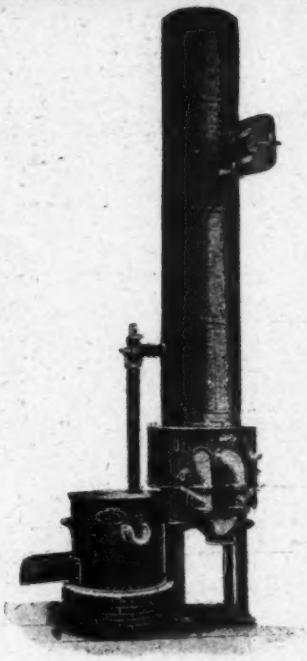
with or without receivers or drop bottoms.

Roots' Blowers,

belt, steam-engine, or electro-motor driven.

Charging Platforms,

Hoists, and Ladles.



ECONOMICAL RESULTS GUARANTEED.

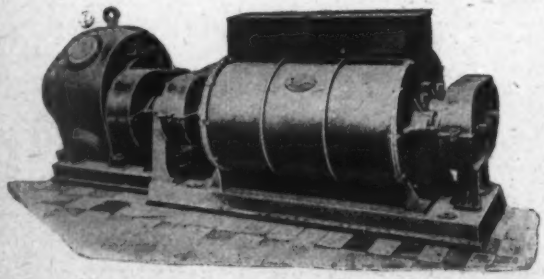
We are also Manufacturers of Steam Hammers, Smiths' Hearths, Centrifugal Pumps and Fans, High-Speed Engines and the "Bradford" Patent Boiler Feed Pump.

We are the original makers of "Rapid" Cupolas as under Stewart's Patent. We make this intimation as other makers are introducing this description, which had become established as a synonym of Stewart's Cupolas.

CONTRACTORS TO HIS MAJESTY'S GOVERNMENT.

THWAITES BROS., LTD.,

Vulcan Ironworks, BRADFORD.



Telegrams—
"THWAITES, BRADFORD."

Telephone—
Nos. 3459 and 3460 BRADFORD.

London Office:
96 & 98, Leadenhall Street, E.C.

Catalogues on Application.

"FOUNDRITE."

"FOUNDRYMEN have been seeking this material for years."

Supplied only in 40 gallon Casks. No bulk broken.

FOUNDRITE is another German speciality superseded and improved.

FOUNDRITE is **the** binding material for moulding sand and cores.

FOUNDRITE SUPERSEDES and makes unnecessary all classes of **CORE GUM, LINSEED OIL and all other BINDING material.**

FOUNDRITE will renew old and burned sand, making it usable over and over again.

FOUNDRITE makes **CORES** unbreakable and the use of **core irons** unnecessary.

FOUNDRITE leaves **CORES** perfectly porous and does **not shrink.**

FOUNDRITE has been **"found right"** for all **Sand binding** in the Foundry **for all purposes.**

FOUNDRITE is supplied in **LIQUID** form ready for use. Dilute with Water.

The porosity of the core is perfect, and cores so made do not shrink.

No blowing, cracking, crumbling, honeycombing, or loss of strength can take place.

COST OF USING "FOUNDRITE."

For ordinary work the price is about One Penny per gallon.

FOUNDRITE is used in all important Foundries in Great Britain and the Continent.

FOUNDRITE SAVES MONEY.
FOUNDRITE PREVENTS WASTERS.

Telegraphic Address—"MOROD, SHEFFIELD." **Telephone 4318.**

HEDLEY MOORWOOD & Co., Ltd.,
21, Church Street, SHEFFIELD.
FOUNDRY EXPERTS.

CUPOLA BRICKS

FOR LINING
ORDINARY AND PATENT
CUPOLA FURNACES.

JOHN R. FYFE & CO.,
SHIPLEY, Yorks.

JOHN HALL & CO.
OF STOURBRIDGE, LIMITED.
STOURBRIDGE, ENGLAND.

Manufacturers of
FIRE BRICKS, BLAST FURNACE BRICKS AND CUPOLA BRICKS.

FERRO-VANADIUM. * * * * * **FERRO-TITANIUM.**
SILICO-MANGANESE { **23/30** % Silicon. **65/70** % Manganese and **1** %, **2** %, **3** %, Carbon Maximum.
FERRO-SILICON Containing **25** %, **50** %, **75** % Silicon.
FERRO-CHROME **65/70** % Cr. & **1** % up to **8/10** % Carbon Maximum.
ALUMINIUM **98/99** % Purity. *In Notched Bars and Half Round Sticks and Granular.*
WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.
EVERITT & CO., 40 CHAPEL ST., LIVERPOOL.
Telegrams: "PERSISTENT." Telephone No. 1134 (3 lines).

THE ORIGINAL AND BEST CORE COMPOUND.

"SPERMOLIN"

(Registered Trade Mark.)

For particulars apply to the Makers:—

THE SPERMOLIN CORE CO.,
George Square,
HALIFAX.

Telegrams:—"SPERMOLIN, HALIFAX." *Telephone:—397 Halifax.*

Helps to solve the War-time Labour Problem

Mex Fuel Oil is suitable for all types of industrial furnaces, locomotives, land and marine boilers, and is efficient, clean, and low in cost. Its use in industrial furnaces saves labour, space, and time, and increases production—all important features during the War. Engineers sent to any part of the country for consultation. . .

Write for illustrated book "Mexican Fuel Oil."

ANGLO-MEXICAN PETROLEUM COMPANY, LTD.,

FINSBURY COURT, *Fuel Oil (U.K.) Dept.,* LONDON, E.C.

Telephone—2704 City. *Telegrams—"Mexprodux, Ave, London."*

A NEW STEEL BARROW

(PATENTED).

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is 25 per cent. greater than the ordinary style, yet it can be wheeled with half the labour, and can be emptied much more quickly. It is a perfectly balanced barrow, and a full load can be easily wheeled by a boy.

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS and PLATES up to 15 FEET LONG.
RANGE OF GAUGES 8 to 30 W.G.
RANGE OF WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS, BOGIES, TRUCKS, GUTTERS, PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and PUTTYLESS ROOFLIGHTS.

BRABY for galvanized corrugated **STEEL**
SHEETS: "EMPRESS" and "SUN" BRANDS.

FREDERICK BRABY & Co., Ltd., Eclipse Iron and Galvanising Works and Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast, and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Telegrams—"Braby, Glasgow."

COMPLETE PATTERN SHOP PLANT

LESS COST, LESS POWER, LESS ROOM—AND BETTER RESULTS.

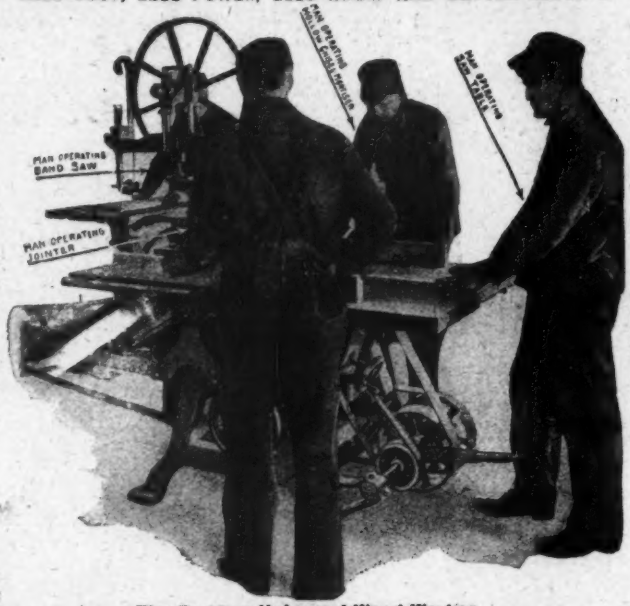
Which will pay for itself in six months.

1265 Universal Wood Workers in actual operation.

500 of this number built and sold in one year.

Made in 7 different sizes and for any particular purpose.

COMPLETE LINE OF WOOD WORKING MACHINERY KEPT IN STOCK FOR IMMEDIATE DELIVERY.



The Famous Universal Wood Worker.

Our Famous Universal Wood Worker, when equipped with all possible attachments, stands complete as a band saw, jointer, saw table, single spindle shaper, two-spindle borer, mortiser, tenoner, rim borer, felloe rounder, wheel equaliser, disc sander, drum sander, panel raiser and knife grinder.

Sole British, Colonial and Foreign Selling Agents—

UNIVERSAL MACHINERY CORPN. LTD., 328, OLD STREET, SHOREDITCH, LONDON, E.C.

WILLIAM CUMMING & CO., LTD.,

FOR
IRONFOUNDERS'
BLACKING
PLUMBAGO
BLACK LEAD
CORE GUM
COAL DUST
ETC.

—o—

Write for Quotations.

WORKS—
Kelvinvale Mills, Maryhill, Glasgow.
Sunnyside Blacking Mills, Falkirk.
Old Packet Wharf, Middlesbrough.
Albion, West Bromwich.
Whittington Bracking Mills, Nr. Chesterfield.

IRONFOUNDERS
FURNISHERS
Established 1840.

Also
THE WELL-KNOWN BRANDS
"IMPERIAL"
"EUREKA"
"VULCAN"
"CROWN"

Registered Brand—
"SHALACO"

Telegraphic Address—
Prudence, Glasgow.
Cummin, Blacking Mills, Camelon.
Cumming, Whittington, Chesterfield.

THOS. BROADBENT & SONS, Ltd.

CENTRAL IRONWORKS, HUDDERSFIELD.

TRY A

BROADBENT CRANE

IN YOUR FOUNDRY

AND SAVE

TIME, LABOUR AND EXPENSE.

Tels: Broadbent, Huddersfield.
Tele: 1581 (4 lines).

London Office, Suffolk House,
Laurence Pountney Hill, E.C.

THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

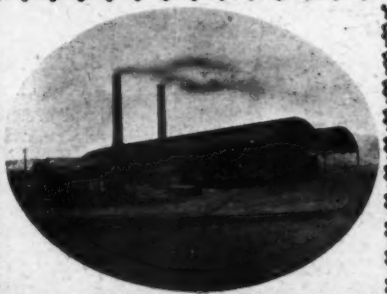
Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it,

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director.

Makers: **C. PORTWAY & SON,** TORTOISE STOVE & PORTWAY PORTABLE OVEN WORKS, **HALSTEAD, ESSEX.**



THOS. WILKINSON & CO., LTD.
MIDDLESBROUGH.

BLACKING
PLUMBAGO
BLACKLEAD
FLUOR SPAR

CARLTON PATENT BLACKING.
FOR EVERY KIND OF MOULD.

AGENTS FOR
"GLUTRIN"
CORE BINDER.

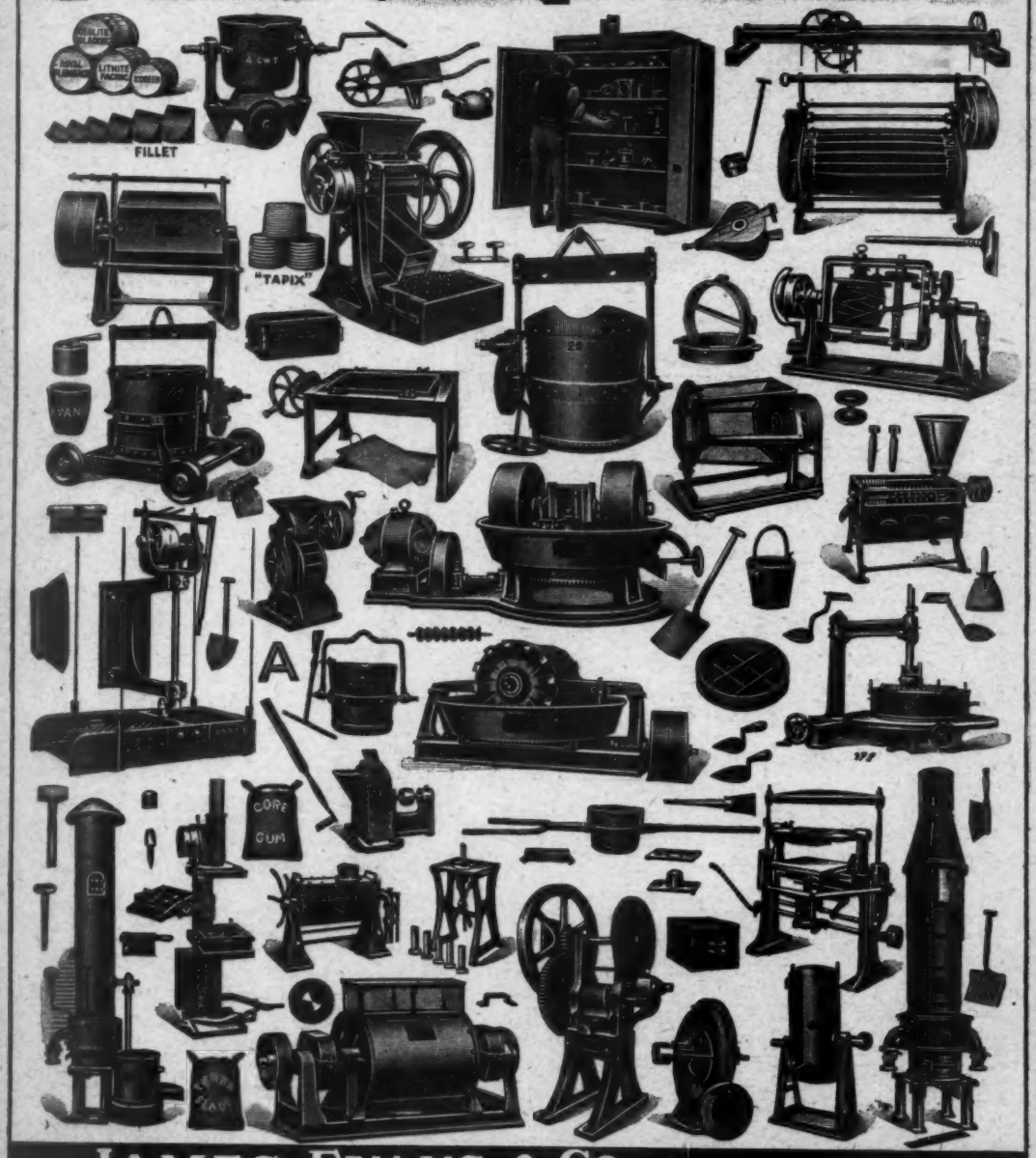
CHAPLETS
NAILS & SPRIGS
CORE GUM, &c.

COMPLETE

Foundry Equipment.

Telegrams: "LADLES" MANCHESTER

Telephone: "No 2297 CENTRAL" MANCHESTER



JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.